Original MONEY-MAKING PLANS SEE PAGE 892

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HUGO GERNSBACK
Editor

190 Miles an Hour with Ball-Wheel Train
SEE PAGE 873

Greater Values in New Driver Power Tools

We have important news for the amateur craftsman who wants to start an inexpensive home workshop that produces finished work, or for the "old-timer" in woodworking who enjoys owning new tools with remarkable engineering advances that save both time and money. After over a year of designing and perfecting, the Walker-Turner Company's staff of engineers has developed an entirely new group of Driver Power Tools—the Series "500" line. These tools incorporate every detail and refinement of heavier, more expensive tools, yet in not a single instance has the quality of materials been sacrificed to effect a saving in cost.

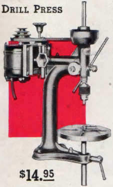
Exhaustive factory and workshop tests have brought to light amazing results from these rugged machines. Although each tool costs but very little, the prices are by no means indicative of their high value.

QUALITY AND EFFICIENCY IN EVERY TOOL

For actual performance, usefulness and sturdiness the Series "500" tools will easily match other machines several times more expensive. A point-by-point comparison proves that the Series "500" line is the best buy on the market. Such features as the S.K.F. ball bearings of the spindle shaper, the Jacob's key chuck on the drill press and many similar items on the other machines have never before been built into tools selling at these low prices.

The new "500" Jig Saw illustrated at the left, and priced at only $9.25, less the motor, was tested by continuous running at high speed day and night without making adjustments or adding oil. After running six weeks without a single stop, the machine was dismantled and carefully examined. Not even a blade was broken, nor could any appreciable wear be found on any of the parts! Aside from its ability to withstand long use, this remarkable jig saw reduces noise and vibration to a minimum, so that it can be operated in apartments without fear of annoyance. The splash oiling system, tilting table and bronze bearings combine to make it today's best buy.

Series "500" Drill Press



$14.95
less motor

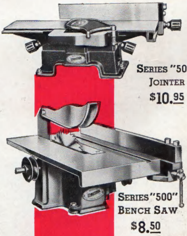
GENERAL SPECIFICATIONS

"500" Drill Press—Excellent for heavy drilling on wood, metals or composition. Handles quickly, efficiently and can be driven at eight different speeds. Has ½-inch Jacob's chuck, machined steel quill, oilless bronze bearings, ball thrust bearing, carefully ground table and rigid frame. An exceptional value at an unusually low price.

"500" Jointer—This machine eliminates drudgery in surfacing rough lumber. Three high-speed steel knives operating from a balanced cutter head provide smooth planing. Adjustable tables and base are solidly constructed of gray iron. New design, convenient guide, and a superior safety guard give added value to this inexpensive tool.

"500" Bench Saw—Exceptionally sturdy with capacity for 2¼-inch cut using 7-inch blade. Table raises and lowers to vary depth of cut. Solid steel ripping guide, removable insert, sawdust chute, oilless bronze bearings. Will match bench saws selling for two or three times its price.

"500" Lathe—Entirely new in design. Features hollow head spindle found only in expensive machines. Tail stock has No. 1 Morse taper. Exceptionally heavy bed 34 in. long, plus an 8-in. swing, make this a particularly good buy.



Series "500" Jointer
$10.95

Series "500" Bench Saw
$8.50

Series "500" Lathe
$11.50

Walker-Turner Co., Inc.
7123 Berckman Street, Plainfield, N. J.

Please send me free of charge your catalog describing in detail the new Driver Power Tools.

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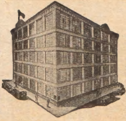

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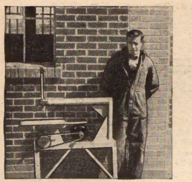

● *This attractive jig-saw, with adjustable table, was built for his workshop by B. N. Seibert, of Fort Collins, Colo., from old auto parts, and won a first prize in the Old Auto Parts Utilization Contest, the twelfth awards of which have just been made. It is evident that the interest in this keeps up; and articles on this subject will continue to appear in* EVERYDAY SCIENCE AND MECHANICS, *though the contest has now closed. The grand prize awards will be announced in the January issue.*

ARTICLES IN OUR NEXT ISSUES:

REVOLUTIONARY AIRCRAFT DESIGN

A new and remarkable type of aircraft has just been developed abroad. It resembles nothing else in use, and appears to have solved the problem of rising and descending perpendicularly, as well as hovering; it can fly backward or forward. The "Airwheel" will be described in the January issue.

WHAT SHALL I INVENT?

Many an ingenious person asks this question—"What will pay me to develop it?" An article by a man who has made several inventions himself, and devoted considerable study to the history of invention, will answer this.

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With articles on interesting scientific developments and new mechanical equipment, there will be many others showing how the reader can busy himself either in his hobby or for money-making purposes. Besides an article on the latest Christmas toys now available, there will be one on making interesting novelties of a scientific type for this purpose.

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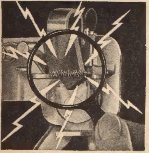

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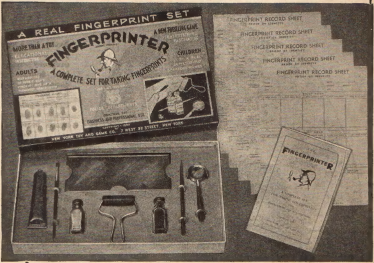

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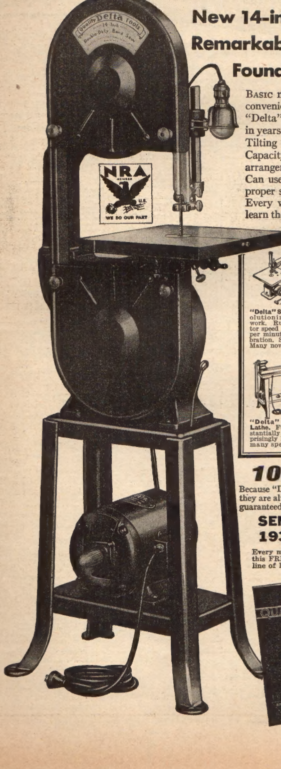

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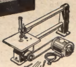

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EVERYDAY SCIENCE AND MECHANICS

EDITORIAL

Invisibility

By HUGO GERNSBACK

FOR some reason or other, when the word "invisibility" is mentioned, most people immediately think of invisibility of the human body. Invisibility, however, extends much further than this single application and, as a rule, because we do not stop to think about the subject, we do not associate invisibility with other subjects, as we should.

Invisibility, in other words, may be defined as the impossibility of seeing or perceiving certain forms of matter. And it makes very little difference whether the object be viewed by means of the human eyes or through a photographic lens. It is also surprising, when we stop to think of the large quantity of physical matter which is quite invisible on account of its transparency. First of all, there is, of course, the terrestrial atmosphere; this is composed of a number of gases, all of which are so transparent that they are fully invisible. It becomes almost impossible to actually see the atmosphere; and you only get an inkling of it through the human eye; as, for instance, when you look at the sunset or moonrise, or when you look over a heated body, such as a stove; then the objects behind take on a glimmering characteristic.

Practically all gases are invisible to the human eye; there are, however, some exceptions, such as chlorine, which is green and bromine, which is brown, being the best known.

But many solids are also invisible, because of their great transparency, the best known, perhaps, being glass. If you stand in front of a perfectly clear piece of plate glass it can no longer be perceived; particularly if the light originates in front of the beholder and behind the plate glass, as in show windows. If the glass is not of a good grade, but the ordinary variety, which contains air bubbles, and is not perfectly straight, it is no longer perfectly transparent, and thus not invisible. Also, if the thickness of the glass becomes too great, it is no longer invisible; this is due mainly to the diffraction of light within the glass itself.

Water too, particularly if it is distilled, becomes invisible when not in motion. There are liquids which share the same property with water; many acids and chemical solutions, such as, for instance, benzine, carbon-tetrachloride (known better under the trade name of Carbona) and a host of other liquids become invisible after complete refining, if placed in perfectly transparent vessels.

Among the solids besides glass, we have substances as quartz, diamonds and others which are perfect transparencies.

Then we have a host of exceedingly thin films which also become invisible, from celluloid down to soap films, and many others, always providing that the films are viewed in the right light.

Surprising as it may seem, light itself is totally invisible, and perfectly transparent. The sun is shining, as we all know, during the night, as well as during the day. During the night time, we do not see the sun; because the earth's turning around puts us in the shadow; yet sunlight is streaming *past* the earth continuously and, if light were visible, all you would have to do is look skyward during the night and you would see sunlight all around. You do not, because sunlight is invisible—so much so, in fact, that it appears not to exist at all. The reason, of course, is that the sunlight streaming through space, where there exists a very high vacuum, strikes no particles which would reflect the light and thus make it visible to your eye.

Invisibility, in animal tissue, also exists. Certain forms of jellyfish cannot be seen in absolutely clear water due to their complete transparency, particularly when they are not moving. When in motion, the ripples caused by their motion make them visible.

Invisibility, as applied to the human body, does not exist at the present time; because it has not been possible to make human tissue and bones totally transparent in ordinary light. A favorite subject with fiction writers—that is, invisibility of human beings—has not, as yet, been accomplished. It is doubtful that it can be accomplished at any time in the future with a living human body, although, of course, it may not be impossible. It is conceivable that certain chemicals, introduced into the human body, could make it even more than *translucent*—that is, transparent—and if such chemicals, not harmful to the human constitution, could be evolved, then, of course, a naked man might walk the streets without anyone's perceiving him; because you would look right through him, just as you would if you looked through a clear pane of glass.

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Breaking Up Tornadoes

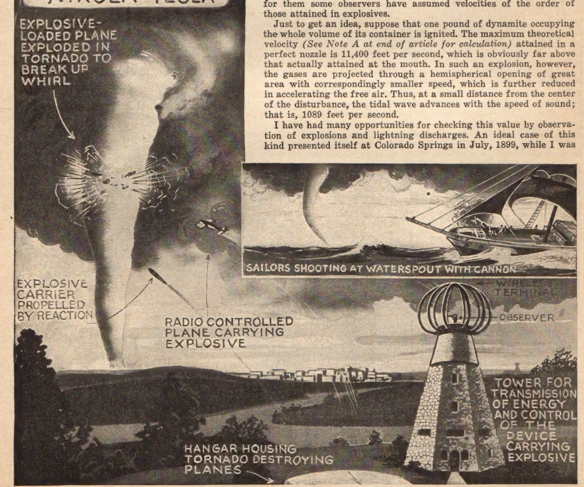
By NIKOLA TESLA

EVERY year whirling tornadoes cause great damage in the United States; and this disaster, like earthquakes, has hitherto been accepted as unavoidable. But the great scientist and inventor, Nikola Tesla, who has given the matter special study, both experimentally and theoretically, here proposes a practicable plan for the organization of a national government service to combat and break up tornadoes, when forming; just as a fire department responds to an alarm and overwhelms the blaze while it is still small. It is to be hoped that this proposal will be met by official investigation and adequate action at Washington.—EDITOR.

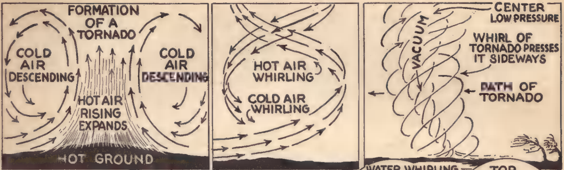
● MANY reports of tidal air waves, cyclones, and especially of tornadoes describe actions which are unbelievable; and to account for them some observers have assumed velocities of the order of those attained in explosives.

Just to get an idea, suppose that one pound of dynamite occupying the whole volume of its container is ignited. The maximum theoretical velocity *(See Note A at end of article for calculation)* attained in a perfect nozzle is 11,400 feet per second, which is obviously far above that actually attained at the mouth. In such an explosion, however, the gases are projected through a hemispherical opening of great area with correspondingly smaller speed, which is further reduced in accelerating the free air. Thus, at a small distance from the center of the disturbance, the tidal wave advances with the speed of sound; that is, 1089 feet per second.

I have had many opportunities for checking this value by observation of explosions and lightning discharges. An ideal case of this kind presented itself at Colorado Springs in July, 1899, while I was


EXPLOSIVE-LOADED PLANE EXPLODED IN TORNADO TO BREAK UP WHIRL
SAILORS SHOOTING AT WATERSPOUT WITH CANNON
WIRELESS TERMINAL
OBSERVER
EXPLOSIVE CARRIER PROPELLED BY REACTION
RADIO CONTROLLED PLANE CARRYING EXPLOSIVE
TOWER FOR TRANSMISSION OF ENERGY AND CONTROL OF THE DEVICE CARRYING EXPLOSIVE
HANGAR HOUSING TORNADO DESTROYING PLANES

The old idea of shooting at a waterspout was correct in principle, but insufficient in force. Yet, as calculated here, the force of a tornado can be overcome by modern explosives, which might be efficiently and safely applied as shown.

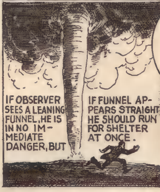


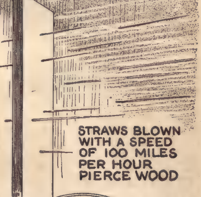
carrying on tests with my broadcasting power station (which was the only wireless plant in existence at that time). A heavy cloud had gathered over Pike's Peak range, and suddenly lightning struck at a point just ten miles away. I timed the flash instantly and, upon making a quick computation, told my assistants that the tidal wave would arrive in 48½ seconds. With exactly the lapse of this time interval, a terrific blow struck the building, which might have been thrown off the foundations had it not been strongly braced. All the windows on the exposed side and a door were demolished, and much damage was done in the interior. Taking into account the energy of the electric discharge and its duration, as well as that of an explosion, I estimated that the concussion was about equivalent to that which might have been produced by the ignition of twelve tons of dynamite. Though the mechanical effects of lightning bolts diminish with the square of the distance, they are still plainly observable within the range of six hundred miles.

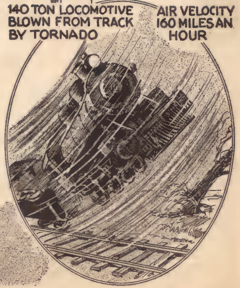
It should be borne in mind that these actions are of very small duration, and that a steady gale of such velocity would produce appalling effects. It would quickly erode and grind up the hardest materials, fuse metals by friction and impact and burn up anything that is combustible. Objects, no matter how large and heavy, would be carried off like feathers, and even a mountain range could not resist for any considerable period of time; since the pressure on an area normal (perpendicular) to the direction of the air blast would be close to three thousand pounds per square foot. Certainly, the inhabitants of this globe have reasons to congratulate themselves that such storms are impossible. Tornadoes, such as actually occur, are bad enough.

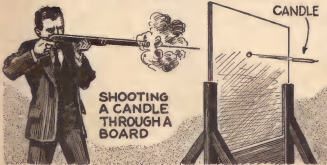
The fact is that relatively very small velocities of the wind are quite capable of producing the actions noted even though they may appear astonishing and puzzling at first thought. To illustrate, consider the mechanical effect of a stalk of dry grass or straw hurled normally against a wooden plank with a speed of only 150 feet per

(Continued on page 905)

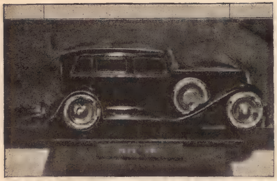

IF OBSERVER SEES A LEANING FUNNEL, HE IS IN NO IMMEDIATE DANGER, BUT
IF FUNNEL APPEARS STRAIGHT HE SHOULD RUN FOR SHELTER AT ONCE.


STRAWS BLOWN WITH A SPEED OF 100 MILES PER HOUR PIERCE WOOD

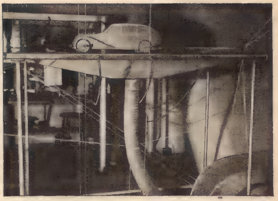

140 TON LOCOMOTIVE BLOWN FROM TRACK BY TORNADO
AIR VELOCITY 160 MILES AN HOUR


CANDLE
SHOOTING A CANDLE THROUGH A BOARD

The formation of a tornado is shown above; it spins, as do the waste water and the top. Its tremendous velocity of rotation enables it to accomplish many of the freak results shown; just as when the soft candle is shot undamaged through a hard board.



The lines of air-flow around an automobile model are made visible on a plate covered with oil and lampblack; light streaks appear where the wind pressure is highest. The shapes which give least resistance are thus identified.



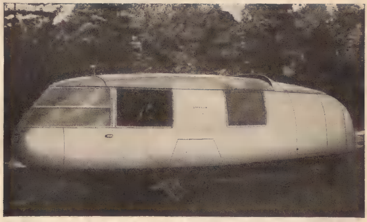
Car model set up for air-resistance test at University of Michigan.

More Speed for Less Power

■ NATURE has streamlined the most active fish and the swiftest flying birds, so that they may move through their respective native elements with the least possible resistance. And man has carefully developed the contours of the airship and the airplane. The automobile, bus, and even trucks, however,

(Continued on page 919)

What is he doing in the bottle?
(See page 919)

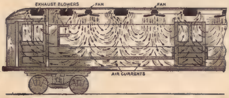


The Dymaxion streamlined car, designed for 120 miles an hour by Buckminster Fuller. (G.E. Photo)

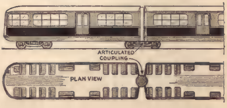
Streamlines for City Service Cars to Make Transit More Rapid

■ FOLLOWING close the railway lines' new purchases, the New York transportation lines announce new designs. The train above, to be run on the Brooklyn elevated lines, will carry 674 passengers. Aluminum makes it a third lighter, giving more passenger capacity with less weight on the track, and quicker braking. An automatic compensation unit regulates this.

The new subway car of the I.R.T., with sealed windows and controlled circulation, greatly reduces the noise of travel.

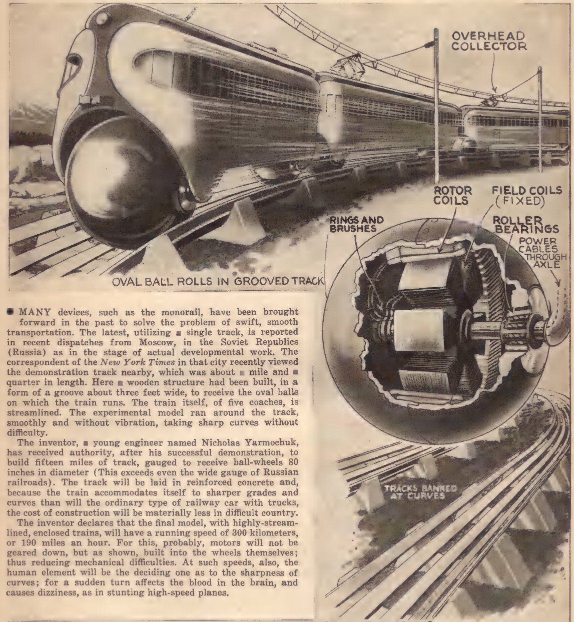


New "silent" car designed for the Interborough Rapid Transit Co., New York City. The air is also better.



A single car, in jointed sections, for the New York Rapid Transit Corp. (B.M.T.) Its streamlines increase speed a third, and the aluminum construction reduces operating and maintenance costs. The force of braking is applied in proportion to the load carried.

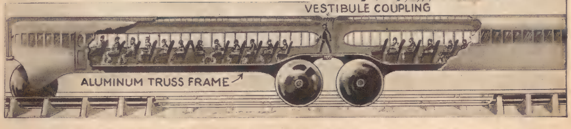
190 Miles an Hour on Ball-Wheels



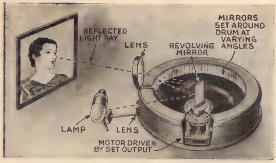
● MANY devices, such as the monorail, have been brought forward in the past to solve the problem of swift, smooth transportation. The latest, utilizing a single track, is reported in recent dispatches from Moscow, in the Soviet Republics (Russia) as in the stage of actual developmental work. The correspondent of the *New York Times* in that city recently viewed the demonstration track nearby, which was about a mile and a quarter in length. Here a wooden structure had been built, in a form of a groove about three feet wide, to receive the oval balls on which the train runs. The train itself, of five coaches, is streamlined. The experimental model ran around the track, smoothly and without vibration, taking sharp curves without difficulty.

The inventor, a young engineer named Nicholas Yarmochuk, has received authority, after his successful demonstration, to build fifteen miles of track, gauged to receive ball-wheels 80 inches in diameter (This exceeds even the wide gauge of Russian railroads). The track will be laid in reinforced concrete and, because the train accommodates itself to sharper grades and curves than will the ordinary type of railway car with trucks, the cost of construction will be materially less in difficult country.

The inventor declares that the final model, with highly-streamlined, enclosed trains, will have a running speed of 300 kilometers, or 190 miles an hour. For this, probably, motors will not be geared down, but as shown, built into the wheels themselves; thus reducing mechanical difficulties. At such speeds, also, the human element will be the deciding one as to the sharpness of curves; for a sudden turn affects the blood in the brain, and causes dizziness, as in stunting high-speed planes.



The possible methods of driving the ball-wheel train are many. That shown makes the wheels themselves the armatures of the motors.

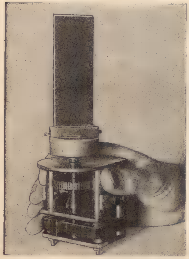

REFLECTED LIGHT RAY
LENS
REVOLVING MIRROR
MIRRORS SET AROUND DRUM AT VARYING ANGLES
LAMP
LENS
MOTOR DRIVEN BY SET OUTPUT

The scanning method of the newest Mihaly home television receiver.

New German Televisor for Homes is Simple

Single Small Mirror Replaces Cumbrous Disc or Drum

By DR. EUGEN NESPER (Berlin)

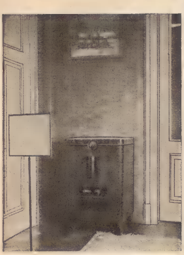


The motor of this small mirror is the only moving part, and power is trifling. It is supplied by the plate current of the power output tube of the television radio receiver, which works on short waves.

■ THE newest television receiver shown by D. von Mihaly, at the tenth radio exposition in Berlin, employs an entirely new and simpler method of scanning. In place of a heavy revolving drum, or disc, requiring high power to drive it, double reflection from a small rotating mirror is employed, in the manner diagramed at the upper left. The mirror is so light that the current of the television amplifier will drive it, at a high rate of speed, in perfect synchronism with the signal. The television lamp fluctuates in brightness with the signal, so that the reflected spot of light is of varying brightness. This falls on the revolving mirror and then to one of the fixed mirrors, inside the drum; which corresponds by its angle to the line at that moment being traced across the screen. By the use of interchangeable drums, it is possible to adapt the televisor to different scanning ratios—that is, up to as high as a 180-line picture, if required. The drum being stationary, does not wear out or get out of adjustment. The power required by the motor is less than a watt—hardly more than an electric clock draws. Even a battery-operated receiver can drive it; and no technical skill in the user is required.

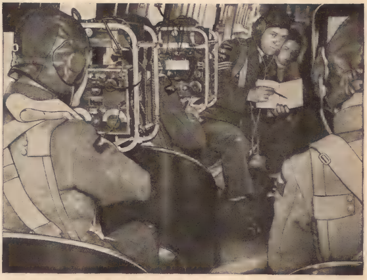
The manufacturing cost, also, is kept down, as compared with other types in use hitherto. The glow-lamp used is less expensive than a cathode-ray tube, and much lower voltages are required for its proper operation.

In Germany, at the present time, transmission of television signals is effected on very short waves—around seven meters—while the accompanying audible program is sent out by the regular broadcast transmitters. The German government, through its post-office department, which operates the telegraph and telephone systems, has been coöperating in the experimental development of television for some time.



The picture traced by the moving beam on the external screen can be seen by the whole home circle. The simple construction makes the cost less than that of other types.

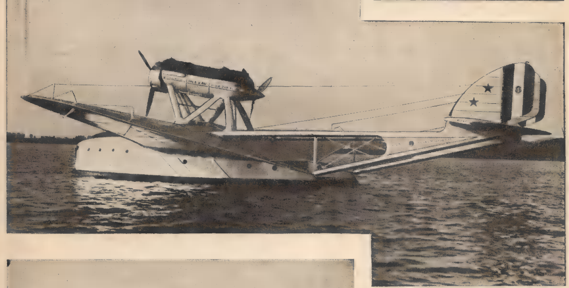
Short-Range Radio Telephony in the Air



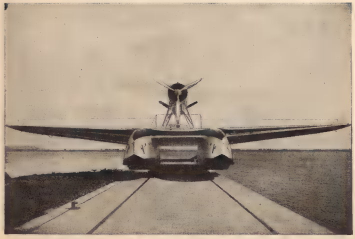
The aviation radio instructor (with book) can talk to his pupils by radio as he stands beside them in this Vickers bomber used for the instruction of British air cadets, who are listening in on the suspended radio receiving sets. In the air, the operators can hear nothing but the transmissions.

Flying Boats *for* Long Flights

■ MANY striking features are combined in the very attractive aircraft illustrated on this page, whose performance last summer was of special interest in America. The light structure is of wood, permitting a large fuel load, and consequently the enormous cruising range of 2,800 miles. The engines, mounted in tandem, are each of 940 H.P., and the 18 cylinders of each are mounted in banks of six, at angles of only 40 degrees apart. They give a maximum speed of 175 miles per hour. The cockpit for pilot and co-pilot is under the engines; radio operator and mechanic occupy one in each hull.



The pride of the Italian Air Force, the Savoia "S-55" long-range patrol boat with which Gen. Italo Balbo crossed the Atlantic. Observe the radio aerials.



The fine lines of the twin hulls and cantilever wing are shown above.

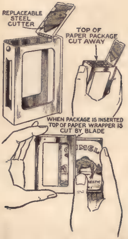
The length over all of each ship is 54 feet, span 72, and height 16½. The weight, empty, is 12,650 pounds, and the fuel capacity 1,500 gallons. On the "good-will" flight of this year, each had a crew of four; but in commercial practice, such a boat will carry twelve passengers, accommodating six in each hull. The radio equipment is extremely efficient; communication with Rome having been maintained during the whole tour, either on short waves (26 and 58 meters) or long (569 and 1120 meters). The external antenna is shown in the pictures; the radio direction finder with its loop is located in the left hull.

Newest Devices

Auto Goggle Wiper

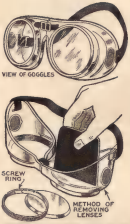
An English inventor has made, for racing drivers, goggles with wipers which [illegible] driven by the small wind-wheel just above them. Moisture is thus readily kept away.

Cigarette Container


REPLACEABLE STEEL CUTTER
TOP OF PAPER PACKAGE CUT AWAY
WHEN PACKAGE IS INSERTED TOP OF PAPER WRAPPER IS CUT BY BLADE
CAMEL

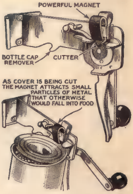
Protects opened package (1577)

Full-Vision Goggles



With these, you can wear spectacles, and [illegible] sidewise (1579)

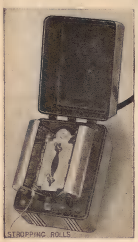
Magnetic Can Opener


POWERFUL MAGNET
BOTTLE CAP REMOVER
CUTTER
AS COVER IS BEING CUT THE MAGNET ATTRACTS SMALL PARTICLES OF METAL THAT OTHERWISE WOULD FALL INTO FOOD

Not only a handy kitchen tool, [illegible] prevents accidents (1580)

Electric Razor Honer

A large electric company has produced a device which will sharpen blades when plugged into any socket and closed. It then operates automatically.



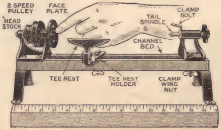
The electric honer opened to receive or remove blade. (1576)

■ MANY ingenious devices brought out, every month, are small, but capable of more applications than the biggest schemes of engineers; because they serve uses of the home, or the office. A number of them are described here every month; and most are obtainable commercially; though some are yet in the development stage, or made abroad and, therefore, not yet sold by representatives here. In such cases, the index numbers facilitating inquiries are omitted.

For instance, the miniature windshield wiper applied to a racing driver's goggles, and spun by the air blast, is not one for which a general demand may be expected. On the other hand, the electric blade sharpener is something that almost anyone (of proper age) can use; it was made some time ago by an electrical manufacturer, but only released outside its organization lately.

The sketches above are ingenious ways of meeting common needs; the cigarette container holds the square shape of a package after opening it neatly, and saves it from being crushed in the pocket. The goggles with transparent cups were developed because accidents had shown that the old type, while protecting workmen against one danger, incurred another for them by cutting off their side view. The magnetic can opener was devised when it was found that metal slivers cut from tin by old style openers drop into food, and often have unpleasant results. Not only does it open the can with a clean cut, but metal particles are pulled out by the magnet.

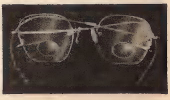
Wood-Turning Lathe for Small Pieces



This little lathe is especially useful for converting scraps of good wood into novelties and presents (1578)

Adjustable Bi-Focals

The auxiliary lenses are adjustable.

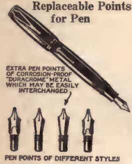


They are here set for reading, but may be moved up or down to suit.

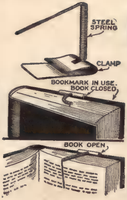
The invention of an optometrist, for attachment to any glasses. They are easier to grind and replace (1581)

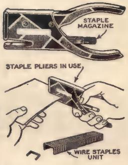
# of Many Uses

Replaceable Points for Pen


EXTRA PEN POINTS OF CORROSION-PROOF "DURACROME" METAL WHICH MAY BE EASILY INTERCHANGED
PEN POINTS OF DIFFERENT STYLES

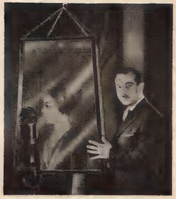
You [redacted] [redacted] several types of points in your fountain pen at will. No tools required for change (1582)





Above, a fastener for [redacted] any light materials (1584) Left, bookmark which always keeps your place as you [redacted] (1585)

"Muting" a Soprano

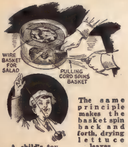


Troubles with soprano voices on the air will be reduced by this, says Phil Boutelje, of Paramount Theatres. (Photo DuPont Cellophane Co.)

Phone Lights Lamp

When the bell rings the lamp is turned on, automatically, and [redacted] find.

Toy into Utensil



The same principle makes the basket spin back and forth, drying lettuce leaves.

A child's toy.

The glasses at the right of page 876 permit the near-vision lenses to be shifted to the user's convenience for various kinds of work or reading; they are quickly adjustable. The little lathe below is [redacted] convenient addition to any workshop, even the best equipped, for small jobs; no special tools [redacted] required. A twentieth of a horsepower runs it.

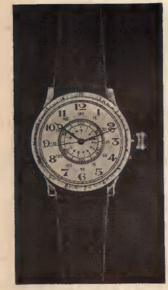
For additional instances of small utilities on this page we see above [redacted] fountain pen with inexpensive points which can be quickly removed and interchanged, like those of [redacted] common pen; [redacted] book marker, invented by one of our readers, which always keeps the place while a book is being read; and [redacted] stapler, pocket [redacted] and decorative, which clips paper or cards together quietly and easily.

The "Yo-Yo" is well known as a toy; French manufacturers have used the principle to make a kitchen utility—a salad drier, which throws water off leaves as it spins.

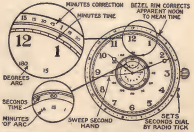
Below, [redacted] watch, designed to order of Col. Lindbergh, for [redacted] navigator's use. When you know "apparent noon" at the place where you are, you make the allowance for the "equation of time," by turning the outer dial the proper number of minutes—and read off the longitude of the place where you are [redacted] the watch—which is keeping Greenwich time. (A bit technical for most timekeepers.) The cellophane bell at the upper right is to soften [redacted] radio singer's voice, as [redacted] "mute" does for violin or cornet. Below is an automatic switch which turns on [redacted] table lamp when the telephone rings; it may be soon on the market.

(Continued on page 922)

Aviator's Chronometer



Lindbergh's watch (Photo A. Wittnauer)



It indicates geography while [redacted] keeps time (1586)

Gasoline Power Washer

Another housewife's friend. To start it, you need only step on the [redacted] (1587)

In inquiring [redacted] to the manufacturer of any device described here, please give the number (in parentheses) printed with the description, and enclose [redacted] stamped [redacted] self-addressed envelope for the reply. We do this [redacted] [redacted] service [redacted] [redacted] readers; and [redacted] [redacted] sell any of the articles described.

New Views from Europe

The "Specter of the Brocken" Poses for His Photograph

■ THE camera of a Swiss photographer has definitely solved the "Brocken Ghost" mystery. This strange phenomenon derives its name from the Brocken, a peak in the Hartz Mountains, Germany, where its appearance used to terrify the superstitious peasants of that region. It is that of a gigantic figure in the clouds around the mountain, whose motions imitate those of the observer.

"Last summer I had for the second time an opportunity of observing the 'Brocken Ghost,'" says Dr. A. Brack, of Zurich, Switzerland. "The first time I saw it on the Sexmoor, a mountain in the St. Gall Oberland; the second time I beheld it on the Säntis. It was at 6:30 a.m. on June 28, when a friend of mine and I reached the so-called Hühnerberggrat on this latter peak. A thick morning fog on the northwest side of the mountain ridge obscured a view of the territory we had climbed, and we deposited our knapsacks in the warm sunshine. Suddenly we noticed in the empty space our shadow, huge and distorted, surrounded by a brilliant, rainbow-hued halo; *i.e.*, what is called the 'Specter of the Brocken.' The apparition was so striking that for a few moments we were simply dumbfounded; and we could now readily understand why this phenomenon has succeeded in frightening many a sturdy mountaineer.

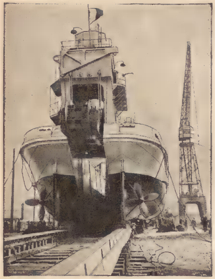
"However, as critical observers, we became at once fascinated by this so-called specter. Strange to say, each of us saw *only his own shadow* and his own halo, although we stood quite close together. Of particular interest were the enormously elongated extremities which, piercing the halo, ended in nothingness. The apparition lasted only a few moments, for the fog rose and fell continuously, but it came back several times.

"Thanks to the rapid receptive qualities of my camera, I was able to take a few pictures, and the one presented herewith is the best of them. After a while, the fog withdrew and we beheld the shadow of our mountain ridge far away in the ether, surrounded by the halo of the 'Brocken Ghost.' This specter is in reality only the shadow of the observer, which the sunshine throws upon a background of clouds."

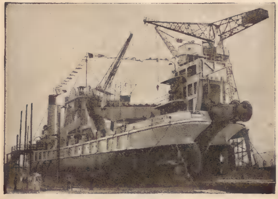
A photograph of the "Brocken Specter," taken on a Swiss mountain, the Santis, by Dr. A. Brack of Zurich, with a Leica camera. (Courtesy Swiss Federal Railroads.)

"Split Ship" is Biggest Dredger

■ FOR clearing harbors and waterways, the new French vessel *Pas de Calais II* is the largest in the world. As will be seen, she is not like a scow, but a sea-going vessel, whose hull is double at the rear to permit raising and lowering the dredge mechanism. This keeps an endless chain of large buckets going, bringing up mud.



Rear view of the "Pas de Calais II" being launched.



The world's biggest dredger on the ways, Dunkerque, France, on the English Channel.

Smallest Organ

■ AT the lower right, a model organ built for "Titania's Palace," a miniature building designed by the British architect, Sir Neville Wilkinson. It is capable of being played, as shown.

Mr. Evans Philips playing the tiny keys with matchsticks.

New Inventions Lately Patented

Roller Boats to Run over Water

■ AS shown on other pages, it is not the speed itself that consumes power, in an airplane, ■ car, or a ship. A body once set in motion, if it encounter no friction, can move for ages, like the planets. It is the resistance of air and of water that must be continually overcome.

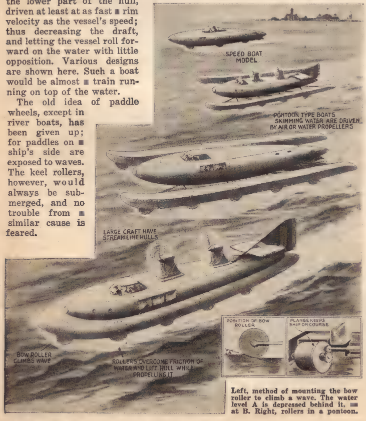
In addition to the design of hull or body, when we are dealing with water, we must consider its *viscosity*. There is a natural limit to the speed with which it can close in behind a propeller, for instance. Water moves more slowly than air; and it is possible to speed up a propeller until it no longer "takes hold" of the water.

We can therefore suppose a vessel with revolving units in her bottom, moving with such speed that there is no friction of water against her hull, and therefore no drag of this kind against her progress.

A recent invention, patented by a resident of London (England), P. C. Lombardini, proposes to obtain high speed in water craft through rollers in the lower part of the hull, driven at least at as fast ■ rim velocity as the vessel's speed; thus decreasing the draft, and letting the vessel roll forward on the water with little opposition. Various designs are shown here. Such a boat would be almost ■ train running on top of the water.

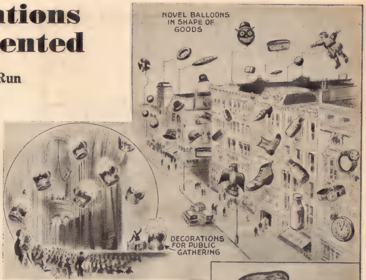
The old idea of paddle wheels, except in river boats, has been given up; for paddles on ■ ship's side are exposed to waves. The keel rollers, however, would always be submerged, and no trouble from ■ similar cause is feared.

The hull of the proposed vessel may be of any proportions. It is proposed to flange the wheels or rollers, thus taking the place of a keel in steadying the craft on her course.

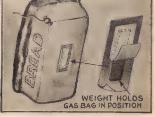

SPEED BOAT MODEL
PONTOON TYPE BOATS SKIMMING WATER ARE DRIVEN BY AIR OR WATER PROPELLERS
LARGE CRAFT HAVE STREAM LINE HULLS
BOW ROLLER CLIMBS WAVE
ROLLERS OVERCOME FRICTION OF WATER AND LIFT HULL WHILE PROPELLING IT
POSITION OF BOW ROLLER
FLANGE KEEPS SHIP ON COURSE

Left, method of mounting the bow roller to climb a wave. The water level A is depressed behind it, ■ at B. Right, rollers in a pontoon.

High-speed boat designs, under U. S. Patent 1,924,949.


NOVEL BALLOONS IN SHAPE OF GOODS
DECORATIONS FOR PUBLIC GATHERING

Expressing the spirit of the occasion with balloons.



The stabilized balloon is the subject of U. S. Patent 1,924,236.

Balanced Balloons for Business or Sport

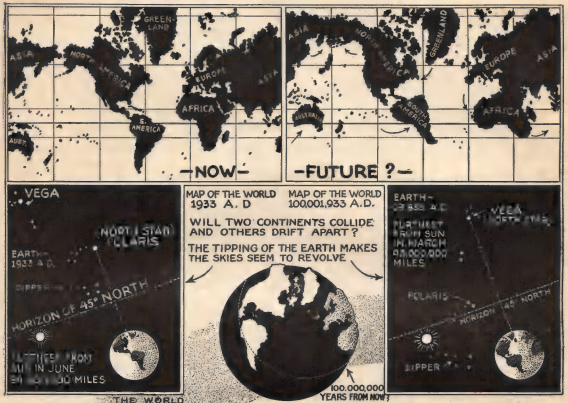
● IT is well known that to throw ballast out of ■ free balloon permits it to rise; while any addition to its weight, or loss of gas, makes it sink. A very slight change in weight produces a considerable change in elevation.

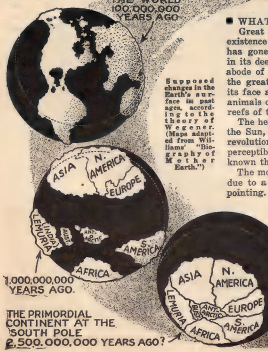
A Chicago inventor has undertaken to design balloons—not for passenger service, but for advertising, amusement, and the like. Hitherto, toy balloons have been filled with illuminating gas, as a rule, giving them a certain excess buoyancy; and, when accidentally released, the balloon would float away serenely into the upper air.

In the design illustrated, it is proposed to turn out balloons moulded or cut to specific designs, appropriate to their message; and to insert into each a weight, exactly adjusting it to that of the atmosphere in which it is to float. Thus, until there was a material leakage of gas, the balloon would float in equilibrium at approximately the same height from the ground; and need only be secured against gusts of wind.

It is suggested also that such balloons would furnish amusing elements in a ball game, when struck with a bat or racket. Whether or not the normal level of a balloon can be regulated within six or eight feet, however, is a question.

100 Million Years from Now





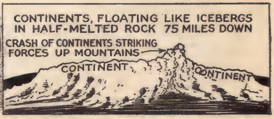
Supposed changes in the Earth's surface in past ages, according to the theory of Wegener. (Maps adapted from Williams' "Biography of Mother Earth.")

■ WHAT does the future have in store for the Earth, as a planet? Great changes have taken place in its, perhaps, three billion years of existence as a solid ball, revolving around the Sun. During that time it has gone through many changes in its surface, but comparatively few in its deep interior, unless in the form of radioactivity. It has become the abode of many different forms of life; some of which have survived, but the greater number of which have perished. It has had the features of its face altered many times, by geological action; and some of the minute animals on its face have made a few trivial alterations—such as the coral reefs of the tropics, and the Panama Canal.

The heavens above are unchanging, to the unaided eye of man; the stars, the Sun, the Moon and, at longer intervals, the planets go through their revolutions; and a single lifetime is insufficient to bring about a change perceptible without measurement. Yet, for two thousand years, it has been known that the skies are changing.

The most striking of these changes is the Precession of the Equinoxes—due to a change in the direction toward which the axis of the Earth is pointing. The axis just now is pointing almost at the North Star; but it is swinging around, just as a top rotates from side to side, while spinning. The Earth takes about twenty-five

(Continued on page 912)


CONTINENTS, FLOATING LIKE ICEBERGS IN HALF-MELTED ROCK 75 MILES DOWN
CRASH OF CONTINENTS STRIKING FORCES UP MOUNTAINS
CONTINENT
CONTINENT

"Human Radio Set" Cured by Faith

You can't feel radio, but [illegible] people think they do.

■ MANY people think they hear or feel radio waves in the air; though none are troubled by the dots and dashes of strong code stations. The press reports [illegible] Westerner, who suffered pains when his set was turned on, was relieved by carrying a wire-wrapped cane, "grounded" in water, and completely soothed by wearing a condenser of large electrical capacity, to draw out "the stored electricity." It is [illegible] scientific demonstration of the power of imagination to cure imaginary evils.

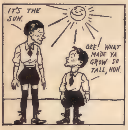
No Power from Atom, Says Rutherford

The scientist gets [illegible] lot of exercise cranking the atom.

■ THE famous atom-smasher, Lord Rutherford, told English scientists recently that no power can be obtained from this process, over and above that used up in it. By the use of high voltages, the kernel or *nucleus* of the atom is broken, and comparatively enormous force exerted explosively. Yet so few atoms can be cracked at one blow that the material tested absorbs power instead of giving it out. Hopeful hearers remembered, however, that the steamboat and the airplane have also been "impossible."

SCIENCE NEWS of the MONTH

Good and Bad Years for Growing

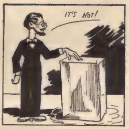

IT'S THE SUN.
GEE! WHAT MADE YA GROW SO TALL, HUH.

Now the weather is blamed, [illegible] well [illegible] the endocrine glands.

■ TREES grow better in wet years, it has been shown, and old buildings can now be dated by the rings in their timbers. The Public Health Service now asserts that not only do trees and other plants grow better at times, but there are good and bad years for the growth of children. That is, in some years vitality is higher; and the little ones "shoot up like weeds." The cause may be varying radiation of the sun, though this is not yet certain. The effect is greatest between the 6th and 16th years.

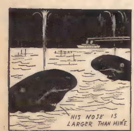
Sense of Touch is Deceptive

■ WHEN you say: "Ouch! It's hot," on touching [illegible] plate, you have just stirred up the "hot spots" in your fingers, and the nerves report accordingly. But Dr. Florian Heiser finds that these spots are not fixed, and do not always give the same sensation when experimented on. It is, of course, well known that touching ice gives an instantaneous feeling not unlike that of putting hot iron in contact with the flesh. It may be necessary to reclassify the nerves of feeling which are of several kinds.



Our [illegible] of heat and cold is not too reliable.

Whale's Nose an Air Conditioner


HIS NOSE IS LARGER THAN MINE.

Whales are certainly the nosiest things alive.

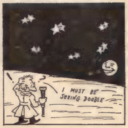
■ IN the old days, the problem was where the whale's head left off and his tail began; but now it has been discovered that the so-called head is really the *nose.* It contains, thinks Dr. William K. Gregory, after dissecting a baby sperm whale, chambers in which stored air is used to recondition that in the great animal's lungs when it is making a long dive — sometimes several minutes. Large valves close off the nose to prevent the escape of breath at such times. A large amount also of oil is kept in the head.

Some Fish are South-Finned

The fishpond traffic cop has [illegible] easy time of it.

■ THAT a man will walk in a circle, if he is in the woods and has no bearings, is fairly well known. This is due to the tendency to step out farther with one leg than with the other. It is now announced by [illegible] Japanese ichthyologist, K. Suyehiro, that there are "right-handed" and "left-handed" fish; that is, some will always swim in the direction from right to left, while others always describe their evolutions from left to right. This is probably due to one-sided muscular development.

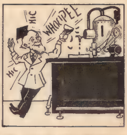
Two Thousand More Double Stars


I MUST BE SEEING DOUBLE

The astronomer finds stars apparently multiplying

■ STARS that are double, or twin suns, make up [illegible] large proportion of all that we see in the sky, though a telescope is required to see them separately. It is now thought that at least a quarter of the visible stars are double, and observations made lately at Bloemfontein, South Africa, have added 2,350 to the number already listed. Many can be recognized as double only by the spectroscope; since they are comparatively too close together for the telescope to "split" them into separate points of light.

Science Turns to the Winery



The chemist also observes a good deal of doubling up.

■ BY the use of *malic* acid, which is the substance giving apples their tartness, it is possible to age wine in three years less time than Nature takes, Dr. R. C. Downs told the American Chemical Society lately. Thus the cost of production is reduced, and the demand met much sooner; while he claims that the flavor and smoothness are equal to that of unexpedited vintages. The malic acid, also, can be produced by the oxidation of *benzene* and *naphthalene*—which are coal-tar products.

[redacted] for the Amateur Photographer

Close-ups; wax-paper substitute for ground glass; enlarging with printing box; and use of field glass for telephoto lens

By GEORGE E. TAYLOR

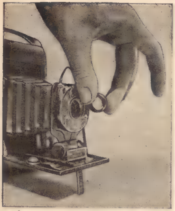


Fig. 1—Portraits [redacted] be taken with many a hand camera, by removing [redacted] of the lenses [redacted] shown.

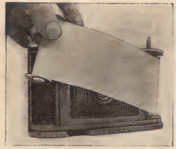


Fig. 2—An excellent substitute for a piece of ground glass is [redacted] paper, threaded to [redacted] spools.

● A SIMPLE ground-glass substitute for the ordinary roll film camera is shown in Fig. 2. Take an empty spool of the size used regularly in your camera, and cut [redacted] piece of good quality wax paper, about eighteen inches long and wide enough to fit the spool. Wind the paper on the spool and place in the camera in the same manner as a roll of film. With the back of the camera off, this wax paper enables you to focus sharply; for indicating the position of the lens when using half of it for close-up work, or when using a field glass as a telescope lens. Mark the correct position of stop by scratching camera bed with [redacted] needle point.

It isn't necessary to have an elaborate set of lenses to take telephoto shots; all you need is [redacted] pair of ordinary field glasses (the power is not important), and your regular camera. Set up the camera and glasses as shown in Fig. 4. Then with [redacted] piece of ground glass (or wax paper [redacted] in Fig. 2) placed behind the camera, and the shutter open, bring a distant object into focus by means of the adjustment on the glasses. Do this again for objects at about fifteen feet, taking note of the adjustment in each case. With these data obtained, you can easily adjust the glasses with the film in place.

First set the camera on the subject, by means of the view-finder, and then line up the glasses by sighting through one side with the other against the lens; but be very careful not to move the camera while doing this. Figs. 5 and 6 show a view taken first without and then with the field glasses.

To take portraits and close-ups of objects it is usually necessary to have [redacted] portrait attachment. However, some cameras with lenses on each side of the shutter will take shots as close as *one foot*, by simply removing the front lens as in Fig. 1. Before placing any film in the camera, find the exact focal distance by the method previously described. At such close quarters the view-finder will probably be inaccurate; so it is best to square up the object with the camera.

If [redacted] few enlargements are desired, and no enlarger is at hand—or you do not wish to go to the expense of purchasing one—it is a simple matter to rig one up as shown in Fig. 3. Place the negative in the printer, and focus by moving the camera. It will be found necessary to give a longer exposure than with [redacted] regular enlarger, but if not successful at first, good results can be obtained after a few trials. To reduce exposure time, substitute [redacted] *photo-flood* bulb for the lamp in the printer.

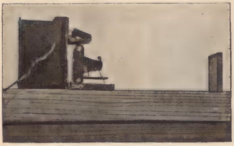


Fig. 3—An enlarger which [redacted] [redacted] made in [redacted] moment. The negative is placed in the printer and projected through the camera upon the printing frame containing sensitized paper.

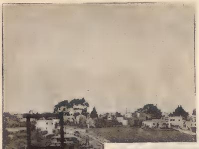


Fig. 5 (above) — Taken with an ordinary [redacted]. Note the square marked [redacted] the photograph.

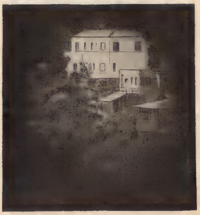


Fig. 6 (right)—The [redacted] scene taken by the [redacted] camera, but through [redacted] side of a pair of [redacted] glasses.

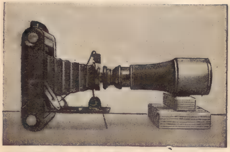
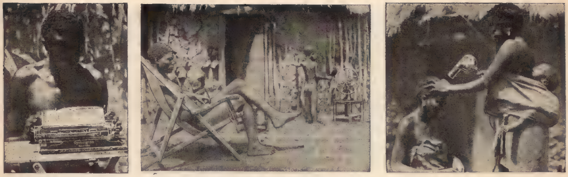


Fig. 4—The manner in which the [redacted] [redacted] set up for taking telephotographs. Sighting is done through one of the tubes of a field glass.

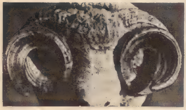


The progress of science and mechanics in South Africa has been rapid, as these views of the Central Africans show. However, the tailor's art has fallen somewhat behind the electrician's. (Photos Akademia, Berlin)

Odd Views from Many Countries

■ AROUND this page we have a bunch of pictorial oddities—usually in the subjects, rather than in the photographs themselves, as in a series of trick photos which appeared in this magazine during recent months.

At the top of the page, pictures taken by an African explorer, showing that civilized devices are interesting to primitive men and women. The ladies seem most interested in the household and beauty-shop devices, of course.



Here we have the Australian gentleman who invented horn-rim glasses.

Below we have a curious-looking customer. Mr. Lamb looks very serious, and his field of vision, like those of many other rather pompous persons, is rather limited.

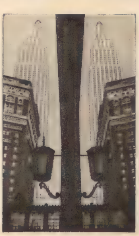
The photograph at the lower left is really peculiar; which permanents go with which can't-runs, and vice versa? If you can figure out how the pair of peaches were posed, you can easily solve it.

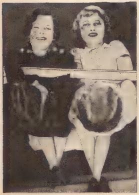
At center right, the Empire State Building becomes twins. If you are a New Yorker, you can readily determine what place the picture was taken from, and, thereby, how it was done. If not, you should be able to guess. It is an excellent picture by a Cuban gentleman, Señor Machado *(another one)*.

At lower center, a turkey-fish from the Fiji Islands; his name is *Pterois Volitans*, and his disposition matches it. Along his middle fin are poison glands; his eyebrows and "wings" are unique.

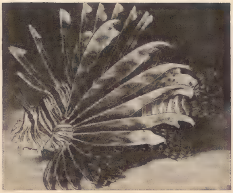
The picture at the lower right is not

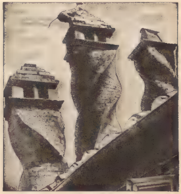
(Continued on page 912)





Something peculiar about this picture; can you figure out how it was taken?

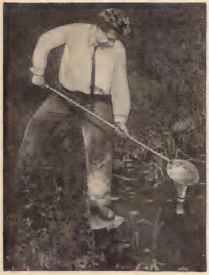




Animal, vegetable or mineral in this picture above? And can the trick photographers solve the two at the right?

Microscopy for

By DR. E. BADE



The cap of a screw-top bottle is fastened to the end of a net, and the "plankton net" thus produced is used for dragging the water for specimens among aquatic plants.

Noteus quadricornis enlarged 200 times. This belongs to the Rotatoria.

The "water bear," Macrobiotus macroyx, enlarged 300 times. A member of the Arachnida.

■ THE greatest amount of pleasure and instruction can be obtained from the microscope when living specimens from stream and pond are examined. Each little pool conceals thousands of tiny creatures which become visible only under the magic influence of the lens. Go into the open and collect some of the "dirty" water. All that is required is a glass jar.

Along the banks of pool and stream are thousands of fragments of decaying vegetation. Parts of leaves, small twigs, small portions of aquatic vegetation, all should be collected and placed in the bottle. On them will be found many interesting forms of life. Some are exceedingly ornamental in character; others again are weird in shape and form. All have a purpose in life. All serve to purify water and all serve as a food for tiny fishes.

Place some of these decayed plant fragments in a shallow dish of water. With the forceps, gently wash the fragment; take a drop of the "dirty" water and examine it under the 'scope. It will be literally alive with tiny and minute organisms which dash hither thither under the eye. A few of them will be large, the majority of them are small.

The floating organisms, which are carried by gentle currents from place to place, can only be gathered with a net. Such a simple net can be made from an old flour bag. Simply change the shape into a cone, and to the larger opening fasten a stiff wire bent into a circle. Where the wire meets, it is twisted together to form a small handle, which is fastened to a stick. The smaller opening of the cone receives the metal top of screw-top bottle, the entire center being removed. This is fastened in place by sewing through tiny holes punched in the side, quite close together. The net is passed through the water; it catches and filters out the small floating and swimming organisms, which are swept down into the little bottle at the end of the net. Unscrew the bottle from the net and pour the contents into the transporting jar.

Another way of collecting minute living organisms too small to see with the naked eye, is to trail a net behind a small boat. A casting net can also be used from the shore, to get those specimens which live in deeper water. Here the net is a cone and it also has a screw-top bottle on the smaller end. The wide end receives a stiff wire ring which must be provided with three small loops. To these loops are fastened three strong strings (fish line) each about a yard in length. The three strings are tied together at their free ends and, where the three meet, a long line is attached.

To operate the net the string is unwound; the cone is cast into the water, as far out as possible, and drawn in. The depth to which the net sinks can be regulated by the speed with which it is drawn in. When drawn in slowly, the net will sink to the bottom and catch all of the lower floating plants and animals, together with some of the ooze from the body of water. In this mud many forms of life are sure to be found.

When the net is drawn in rapidly, almost immediately after it is tossed into the water, it will remain at or near the surface, and only the creatures and plants which bob along with the waves and currents will be caught. Such a net serves well when drawn behind a boat. It is really a matter of personal preference which net is to be used. Try both types as they are easy to make and use.

When at home, transfer the collected material into a small aquarium. Any form or size can be used. If there are quite a few aquatic plants in the material, it need only be placed in a fairly shallow tray of glass and kept near a window. Here material for examination will keep for a week or more.

It can also be transferred to a small balanced aquarium, where the greater part of it will keep for many months. Quite a few of the larger animals so caught (as, for instance, "fairy shrimps," *Daphnia*, *Cyclops*, etc.) will die within a comparatively short time so the larger objects brought home should be examined at once.

Quite a number of various forms of *infusoria* can be bred at home. At times one particular type predominates; but which that will be cannot be determined beforehand. The method of production is simple. In a small aquarium or shallow tray place an inch or two of water. Rain water dripping from a roof is excellent for this purpose. Add a handful of hay, and let it stand. When the water gets dirty, examine it under the microscope. (In place of the hay, lettuce leaves may be used, as well as banana peels and similar substances.) Some of the types of infusoria produced in the solution are the *amœba*, a rhizopoda type of creature, and *paramecia*, an infusoria type also known as the "slipper animal." Many other forms will, of course, be also present. In order to keep these minute organisms alive for greater periods of time, water in which meat has been washed can be added from time to time. This water contains food which will be enjoyed by these animals. In fact this living material for microscopic examination can be kept throughout the entire year.

the Beginner

Part II

The *amœba* is [redacted] fairly slow-moving creature; the "slipper animal," on the other hand, darts hither and thither so rapidly that he can seldom be kept in the field of view for more than a few seconds at [redacted] time. With his rapid gyrations it becomes an impossibility to examine him closely, the same is true of many another creature caught for examination. The thing to do is to slow up his motions. This is not so difficult. The first thing to try is to bring [redacted] tiny drop of the material to be examined on a slide and to cover it with a cover glass. If only [redacted] tiny drop of water is used, the cover glass will usually exert [redacted] gentle pressure upon the creature, and so hold it almost motionless on the slide. A large drop of water, on the other hand, lifts the cover glass higher and free motion can be readily observed. For this last purpose special slides ground and polished with a slight hollow, are available. The drop of water is introduced into the hollow, and the cover glass placed over it. This prevents the material under examination from being crushed or held in place by the cover glass.

Another method of slowing up the motion is to add a little cotton to the glass slide, and tease it out with [redacted] pair of ordinary needles, fitted to wooden handles; then add the drop or two of water containing the objects to be examined and cover with the glass. The fine threads of cotton limit the motions of the tiny creatures, so that they remain within the field of view. This is the simplest and most effective method of restricting motion.

A partial paralysis of the object, especially infusoria, can be accomplished with the aid of carbonated water. This slows down their motion. Use one drop of the material to be examined and one drop of any carbonated beverage that happens to be on hand.

Many killing fluids are known, but few of them are successful enough to show the dead creature in its natural state. This is especially true if it is ciliated ("hairy"). Salt-water creatures are easily killed with an ammonium molybdate reagent; this is also an excellent steel gray stain for animal tissue. Dissolve seven grams of ammonium molybdate in 50 c.c. of water; pour the solution into 50 c.c. of dilute nitric acid (made by pouring 19 c.c. of concentrated nitric acid slowly into 31 c.c. of water) stirring constantly. Shake occasionally until the precipitate is dissolved.

For fresh-water infusoria use [redacted] half-and-half mixture of concentrated copper sulphate in water and potassium bichromate in water.

The general killing agent for all these creatures is a trace of [redacted] 1% osmic acid solution. It will, however, be found that the solutions mentioned above will be quite satisfactory.

Preserving media are of very great value for, with their aid, one can pickle the material brought home from some outing or trip for future observation. Such liquids must keep the tissues as nearly normal as possible, not only in the single cell, but also in complex structures. Unfortunately, [redacted] formula for a universal fixative—good under all conditions—can not be given; for certain subjects require special handlings.

One that most closely fits all demands that may be placed upon it is [redacted] combined killing, fixing and preserving solution, which is made up as follows:

Formaldehyde solution ...	100 c.c.
Glacial acetic acid	40 c.c.
Alcohol 95%	40 c.c.
Water	120 c.c.

Add one part of this mixture to each part of the water containing the material to be preserved. The solution keeps for years and will not deteriorate. Also, the subject preserved may be left in the solution as long as desired. The proportions of the various chemicals may be varied to suit conditions. At times more acid and alcohol may be desired; at others less of this is of advantage.

When preserving material for microscopic examination, be sure to label the bottle, or vial, used; and note the place from which it came. This is essential;

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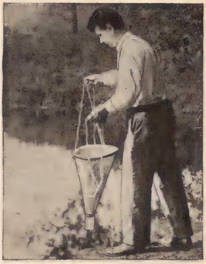
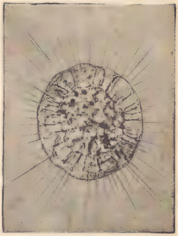
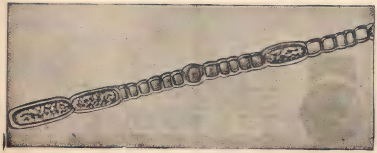


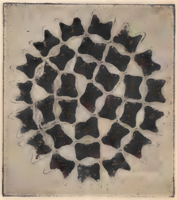
A casting net, made similar to the [redacted] shown on the opposite page, but fitted with [redacted] long line. It is cast far out into the water, and slowly pulled in. Bottle is detached, and the water contains the specimens.



The "sun" animal, Actinosphaerium eichhorni, belongs to the group known [redacted] Heliozoa.



Cylindrospermum stagnale, wh[redacted] enlarged 630 times, as here shown, looks [redacted] a jeweled chain. Belongs to the Cyanophyceae.

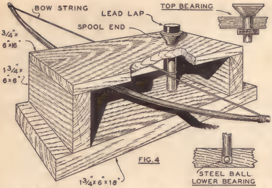


Odd and strange is the Pediastrum duplex, belonging to the Protococcales; here [redacted]nlarged [redacted] times.

Amateur

How to Make

By JOHN M.



A hand-driven lens grinder, operated by manipulating the bow back and forth.

■ THE maker of a reflecting telescope, after he has finished his speculum or mirror, must have eyepieces to magnify the image formed by the speculum. These can be either purchased ready-made, or made by the amateur himself, still further reducing the cost of his telescope. The making of small lenses is not at all difficult, and it is possible with very simple equipment.

For glass, you can purchase blanks molded roughly to shape, thus reducing the necessary grinding; small lenses can be made from fragments of a spectacle lens; ordinary plate glass from mirror or windshield can be used. In the latter case, you can use the already polished surface for the plane side of the *plano-convex* lens, leaving the other side to grind and polish.

First, we cut our lens blank by grinding ■ circular groove in the glass, using medium coarse abrasive, about No. 220, and water, with a cutter made from an empty cartridge shell, a piece of brass tube or a pill box. The cutter is held in the chuck of a drill press; and, using a medium speed, it is brought down on the glass, which lies on the drill-press table. Abrasive, wet with water, is fed to the cutting edge with ■ spoon. Raise and lower the cutter frequently, to allow the abrasive to get into the groove, which rapidly deepens, and cut out a perfect circle.

Fig. 1 shows ■ large cutter of this type, made from a tin can to which a shank has been attached. This cuts out two 4" circles from ½" glass in a little more than an hour. If a drill press is not available, put in ■ square shank (as in Fig. 2) and use your bit brace. Clamp over the glass a ¼" thick board with a hole of the right size, to act as a guide in starting the cutter.

The blank is ground on ■ metal lap, shaped to the curve of your lens. This lap is usually rotated on a vertical spindle, turned by ■ motor. Fig. 3 shows ■ simple and satisfactory grinder; the laps are interchangeable for differently curved lenses. The speed should be about 1800 R. P. M. The lens blank is pitched to ■ metal or wooden handle, of about the diameter of the lens, and 1½" long (Fig. 6). It is dipped first into water and then into the abrasive; and rocked back and forth on the rotating lap until the glass has reached the same curvature as the lap. Continue with finer abrasives until ■ fine-ground surface is obtained, suitable for polishing. Before the final grind, re-form the lap to the correct curve, gauged by a template (Fig. 5). The lap should be a little larger than the lens; and the central part (about ¼" diameter) should be removed so that it will not touch in grinding. A small hole, made at the center of the lap with a drill, will be sufficient.

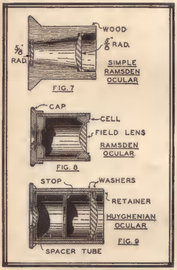
If you wish to be more primitive, use this system: drill holes into a piece of hardwood, ¾" in diameter and 1" deep. Then pour lead into these holes to form lead buttons. Pound a steel ball (from a ball-bearing) into the top of ■ button, and use the button as a lap.

These may be pitched to the center of the upper wheel of a sewing machine, or may be held on a simple wooden spindle rotated by ■ bow, like a Boy Scout's firemaking spindle. Such an outfit is shown in Fig. 4.

All the ordinary eyepiece lenses are plano-convex in form. For such a lens, the radius of curvature is half the focal length of the lens. A steel ball half an inch in diameter will form the correct curve for grinding a ½" focus lens. A double-convex lens, having two curved surfaces, requires only half the curvature in each one; so ■ one-inch steel ball would make a ½" focus double-convex lens. When it has been ground, gauge the lens with a template (Fig. 5).

Consult the table of "Elements" given here for data on the types of eyepieces, and the lenses required. The "field" lens is toward the telescope's mirror or large lens; the "eye" lens toward the observer's eye.

When your fine-ground surface is free from scratches, you are ready to polish. Clean the lap and dampen it with turpentine; then paint on melted pitch until it is about ⅛" thick. Rotate slowly, and form to correct curve with your ground lens. When cool, cut out the center with a knife; the center does little work, and truer curves are ob-



Construction of: simple Ramsden eyepiece; of Ramsden positive type, with lenses crimped into threaded cells; and Huyghenian eyepiece.

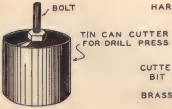


FIG. 1

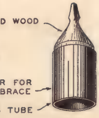


FIG. 2

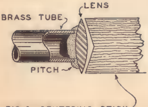


FIG. 6 CENTERING STICK

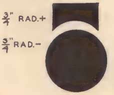


FIG. 5 TEMPLATES

At the left, method of making ■ cutter for cutting circular glass discs, using either a drill press or a hand brace. Fig. ■ shows the method of centering a lens. The stick presses the lens until its axis coincides with the axis of the lathe spindle. In Fig. 5 are "+" and "−" templates for concave and convex lenses, respectively; convex is called "+" and concave "−".

Telescope Making **Part IV**

Small Lenses and Eyepieces

PIERCE

tained if it is removed. You should also scratch a few circular grooves (while the lap is revolving) and trim the outside to the diameter of the lens. Dip the lens into rouge and water, and polish as if you were grinding; rocking the lens back and forth and around to give even wear. It should polish in about 15 minutes. *WARNING:* Provide a guard for the splash thrown off by the rotating lap; or you will get color effects, not planned for, on clothes and wall.

If the lens is to be crimped into the cell, or in any way held by its edge, it should be centered. This is done as follows:—Pitch the lens to a piece of brass tube, as in Fig. 6. This is held in a lathe chuck and turned slowly while you watch the beam of light reflected from the front and back surfaces of the lens. Heat the tube with an alcohol lamp until the pitch softens; and then press the lens with a forked stick until the reflections remain stationary while the lathe rotates. This shows that the lens is then on center with the axis of rotation of the lathe. The edge is then ground by bringing a piece of emery stone against it while it revolves. Wet frequently and continue until the edge runs true.

Types of Eyepieces

The eyepiece is a magnifier; it enlarges the image formed by the objective or speculum. There are positive and negative eyepieces. The focus of the *positive* is in front of the field lens; since the focus is outside the eyepiece, this type can be used as an ordinary magnifying glass to enlarge objects placed in front of it in its focal plane. The focal plane of the *negative* eyepiece lies between the two lenses; so it cannot well be used to enlarge anything but optical images, which pass in through the field lens.

The simplest eyepiece is a single lens; the plano-convex type is best, as it gives less aberration than the double-convex type. It should have the curved surface next the eye. The single lens gives a very brilliant image; but only the center of the field is clearly defined, the edges being somewhat distorted. Stars in the edge of the field will also show considerable color; one side of the image being red and the other side blue. The eye must be held some distance away from the lens for clear sight. See Fig. 11 for its elements.

The Ramsden positive ocular is recommended for use in reflecting telescopes; it is the simplest compound ocular to make. Fig. 7 shows a Ramsden in a simple wooden mount, with the lenses held in place with chewing gum. If care is taken to "square on" the lenses when seating them in the mount, this eyepiece will give excellent results. The Ramsden eyepiece consists of two plano-convex lenses, of the same focal length placed with their convex surfaces adjacent.

Fig. 8 shows a standard Ramsden ocular in section. The lenses are crimped into brass cells that screw into the tube. When the cells are turned in the lathe, there is left a thin edge or lip of brass, which is later turned down to hold the lens in place. This edge is shown in the field-lens cell in Fig. 8, still uncrimped. Before putting in the lens, the brass should be blackened by heating to a red heat, dipping into a saturated solution of copper nitrate, and then reheating. Repeat if necessary. This heating also anneals the metal, so that the crimping operation is easily done. Screw the cell into the tube and place it in the lathe. Put in the lens, and hold it in with the finger, while the lathe is slowly rotated. The lip is easily turned down or "spun," by pressing it with a smooth piece of steel while it turns. Be careful to avoid scratches, and be sure that the lens is firmly crimped into the cell.

A mount that can be made without a lathe is shown in Fig. 9. It is made from brass tubing, which can be purchased,

(Continued on page 911)

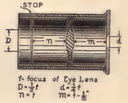


FIG. 11 SINGLE LENS OCULAR

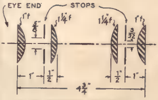
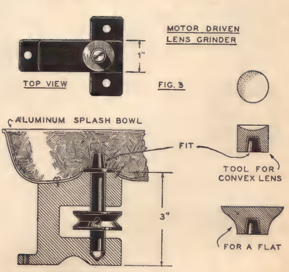


FIG. 12 ERECTING EYEPIECE

The construction of a single-lens ocular, and of an erecting ocular, to bring objects right side up.



Details for making a motor lens grinder. This simple construction will save the amateur telescope maker much time and work in grinding lenses of all types.

FIG. 10

Elements of Huyghenian and Ramsden Eyepieces

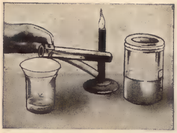
	Huyghen	Ramsden
EFL* of eyepiece	f	f
Diam. of field lens	f	f
Focus of field lens	$\frac{3}{2}f$	$1\frac{1}{4}f$
Diam. of eye lens	$\frac{1}{2}f$	$\frac{5}{8}f$
Focus of eye lens	$\frac{3}{4}f$	$1\frac{1}{4}f$
Separation of lenses	$\frac{9}{8}f$	$\frac{15}{16}f$
Diam. of stop	$\frac{5}{8}f$	No
Radius of field lens	$\frac{3}{4}f$	$\frac{5}{8}f$
Radius of eye lens	$\frac{3}{8}f$	$\frac{5}{8}f$

*EFL—Equivalent focal length

Experimenting with Sulphur

By DR. E. BADE

Sulphur dissolved in carbon disulphide, and allowed to evaporate [illegible] a watch crystal, produces orthorhombic crystals.



Pouring melted sulphur into a folded filter paper, which is supported by the walls of a beaker which contains a small quantity of water.

Plastic sulphur is made by pouring boiling sulphur in a thin stream from a test tube into a beaker of water.

Making a sulphur-spray solution by slaking a quarter-pound of burnt lime with a quart of water, then adding half a pound of sulphur and boiling.

SULPHUR is quite common in its native elemental state, as well as in combination with other substances. A large percentage of native sulphur is crystallized, and much of this is mined in Italy and Mexico. But not only is sulphur found throughout the inorganic world, but it is also widely present in the organic. It forms natural compounds within plant tissue, a good deal of it being found in peppers and onions; while in animal tissues it is present notably in eggs, horns, hair, etc.

Several different conditions or allotropes of sulphur are known and these comprise three solid, two liquid and three gaseous forms. Few of these are stable for any length of time.

Native crystallized sulphur is found in the form of small "orthorhombic" crystals, which may be obtained on evaporating a solution of sulphur. Dissolve ordinary roll or "flower of sulphur," a quantity only about the size of a pea, in 5 c.c. of carbon disulphide. (Keep it away from all flames, for the vapors ignite readily.) Make the solution in a test tube and, when the sulphur is dissolved, pour the liquid into a watch crystal; let the liquid evaporate either under a hood, or out of doors. The fumes should be kept out of the house, for the smell is unpleasant, and the vapor inflammable.

Crystals of the "monoclinic" system, on the other hand, are obtained on heating roll or flower of sulphur slowly in a test tube until it melts and has a light yellow color. Do not heat to a point where the color darkens. Pour the light-yellow liquid on a folded filter paper which is supported by the walls of a beaker, which should contain a little water. When the sulphur has partially crystallized, lift the filter paper and pour the still-liquid portion into the water. The remaining part of the sulphur is prismatic and needle-shaped in form.

The ordinary or orthorhombic sulphur crystals melt at 114.5° C. and they have a density (specific gravity) of 2.06°. The prismatic or monoclinic sulphur crystals, on the other hand, melt at 119° C. and have a density of only 1.96°. A peculiar fact is that these needle-shaped crystals will rapidly change to little crystals of the orthorhombic variety at ordinary temperatures; for the prismatic variety is stable only at temperatures between 96° and 115° C.

Clamp test tube and heat; then heat a spiral of copper wire to redness and dip it into molten sulphur, to get [illegible] sulphide.

Plastic sulphur, the third modification, is obtained by heating the melted sulphur to boiling and pouring it into cold water in a thin stream; then coiling the solidifying sulphur about the beaker in the form of a thin string. A few minutes later the plastic sulphur can be examined and will be found gummy and dough-like in consistency, and quite elastic. This condition lasts only a few days at most; and the sulphur then returns to the ordinary orthorhombic state.

During the melting process, sulphur first becomes a straw-colored liquid. This then darkens as more heat is applied until the sulphur becomes heavy and syrupy. At about 230° C. it is black, and too thick to pour. Heated still more, it becomes thin again; but remains black until it begins to boil at 445° C. Here the two liquid allotropic forms are encountered.

Sulphur, at ordinary temperatures, is quite inert but, at higher temperatures, it is active and readily attacks metals. Mix 2 grams of iron filings with 3 grams of powdered sulphur and introduce the mixture into a test tube; but see that this is no more than one-third full. Clamp the tube in a sloping position on a ringstand. (For safety, place a tray of sand under the test tube. If the test tube should break, the sand will catch the hot, boiling, and perhaps burning, sulphur—and no damage will be done.) On heating, the color of the mixture changes to bright yellow, and then black. The sparking which occurs within the mass is due to incandescent iron. When the reaction is completed, cool and break the test tube to get the sulphide of iron.

The reaction of copper and sulphur is illustrated as follows: Fill a test tube one-third full of powdered sulphur. Clamp it in the ringstand and place tray of sand below. Then take a copper wire, about No. 18 gauge; clean it and wind into a thin spiral. Heat the sulphur to just below the boiling point; then heat the copper spiral red hot and introduce it into the molten sulphur. Leave the wire there until the reaction stops, and then withdraw it from the sulphur.

The iron sulphide previously made can be used to generate hydrogen sulphide. Place a small piece of it in a test tube and add diluted hydrochloric acid. Hydrogen sulphide is generated; the characteristic odor is a sufficient test. A trace of this gas can be detected

(Continued on page 910)

Producing Chlorine Electrically

Alkali-Chlorine Cell Makes Chlorine Available in Large Quantities for the Experimenter

By BRUCE LEHMAN

A CHEAP source of chlorine is something the chemical experimenter often needs; and this is provided by a good alkali-chlorine cell, of the type here described. This cell may be easily made from common materials, and is conveniently operated to produce sodium hydroxide and chlorine, using ordinary salt as the raw material.

When a current is passed through a solution of salt, the primary reactions are the formation of sodium hydroxide, the liberation of hydrogen at the cathode, and the formation of chlorine at the anode. By using diaphragms and proper direction of liquid flow, those three products may be made the main ones. In this way reaction between the caustic soda and the chlorine, and the resultant formation of sodium hypochlorite and chlorate, is prevented.

The actual size of the cell depends somewhat on the amperage available at about 5 volts; allowing about 4 square inches for each ampere supplied to the single cells. The cell described is made up of two sections connected in parallel. Each electrode surface has an area of about 20 square inches, and the cell takes 10 amperes at 4 to 5 volts; but it may also be operated at lower voltages to take 5 amperes.

As shown by Fig. 1, the cell is built up of cathode (B and F) and anode (D) compartments, separated by diaphragms from electrolysis chambers (C and E); the brine being admitted into these last, and caustic soda solution, hydrogen, and chlorine being removed from the other compartments. The wooden frames are sawed and drilled, according to the specifications of Fig. 2, and then immersed in hot paraffin until the moisture is driven out and replaced by the wax.

The cathodes are simply pieces of sheet iron or lead bolted to the end frames. If pure aluminum is used here, direct current is not needed, and the cell may be operated on raw A.C. obtained from a step-down transformer; since the current can pass in but one direction through a cell containing an aluminum electrode. If an aluminum plate is used with A.C., the part of its fastening bolt which is inside the cell *must be insulated.* This is easily done by melting a little pitch from an old dry cell and completely covering the bolt head.

The best anode would be a graphite plate, and a carbon plate would be very good; but in this case neither of these was available, so carbon rods from an old "B" battery were used. These can be threaded on one end, with dies purchased in the ten cent stores, and screwed into holes tapped into the metal strip, as in Fig. 3. The work should be done carefully and the brass cap must be removed. Five-sixteenths was the proper size die for the carbon rods used in this case. It is well to heat the carbon rods to a red heat, to drive out the heavy oil with which they are usually impregnated. If desired, instead of threading, the brass capped ends of the rods may be soldered to a metal strip. In either case, the metal strip is fastened to the anode frame by a flat-head bolt passing through strip and frame. Any metal parts inside of the anode compartment must be insulated with a layer of melted pitch.

The diaphragms are most easily made of asbestos paper, such as used for covering furnace pipes. They are cut out in rectangles the same size as the outside measurements of the frames and holes punched in them for the assembling bolts. As the paper is rather weak when wet, it may be supported by a piece of coarse canvas on each side or, better, by having, on the side towards an electrode, a piece of ordinary window screening which has been insulated by painting with pitch cut in gasoline. Care, however, is required to avoid filling up the holes in the screen.

To assemble the cell, lay down end piece A, with its attached cathode up, and the four bolts in place, then place in order cathode frame, B; a diaphragm; electrolysis frame, C; a diaphragm; the assembled anode frame, D; a diaphragm; the other electrolysis frame, E; the fourth diaphragm; the second cathode frame, F; and the other end piece, G, with its attached cathode. The pile of frames is then bolted tightly together.

The passages for gases and liquors are made of glass tubing, as shown in Fig. 1. The chlorine exit is in the center of the top

(Continued on page 923)

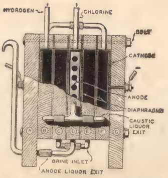
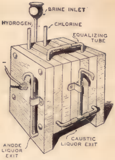
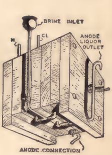


Fig. 1—A cut-away section of the chlorine cell. When current is passed through the solution of sodium chloride contained in the cell, quantities of sodium hydroxide, hydrogen gas and chlorine gas are produced from common salt.



When finished and ready for operation, the alkali-chlorine cell will appear similar to this drawing.



A sort of worm's-eye view of the bottom of the cell, showing connections.

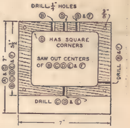


Fig. 2—Details for cutting the wooden members which form the cell. Use ½" to ¾" lumber.

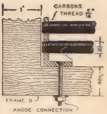


Fig. 3—This illustration shows how connections to the carbons are made through the metal strip.

SCIENCE DIGEST

■ "Science Digest" is a new feature, a review of the scientific news and events of the month, written in a brief, simple and non-technical language. It aims to supply to our readers a quick summary that they would, ordinarily, have to read many publications to secure.

Human Bodies Brew .001%

■ AT the recent meeting of the American Chemical Society, Dr. T. E. Friedmann of the University of Chicago stated that the tissues of the human body contain normally ten parts, in one million, of alcohol. A test for intoxication was described, in which a drop of blood is mixed with a potassium permanganate solution. If the subject from whom the blood is drawn has been drinking, a measurable quantity of the permanganate is used up in oxidizing the alcohol.

Infra-Red Rays Get Under Skin

■ IN recent television experiments, in England, it is reported, the young lady subjects had to don heavier clothes. The photo-cell at the television camera was too sensitive to the infra-red, or heating rays, given off by the body, and to which the garments were almost transparent. Dr. Walter Clark, of the Eastman Kodak Laboratories, reports that, similarly, infra-red photographs may be taken of details of the body underneath the skin, and invisible to ordinary light.

Is Water Really Not H_2O?

■ "WHATEVER water may be" says Dr. E. C. Bingham in *The Review of Physical Instruments*, "it most certainly does not behave like a substance having the formula H_2O." This conclusion is based on the theory that the flow of liquids (the subject of the new science of *Rheology)* should be controlled by their *viscosity*, or stickiness, in accordance with the shapes of their molecules. While this sounds rather theoretical, the mechanical use of lubricants, adhesives, and even metals depends on their viscosity. For a measuring unit of viscosity, Dr. Bingham suggests the *"poise"*; a word having no relation to the operation of a balance, but derived from the name of a French scientist, Jean Poiseuille. The viscosity of water, then, at 68° F., will be one centipoise: that of alcohol, less; that of wax, say, enormously higher.

Crows Do Not Fly Straight

■ AS the crow flies has been a synonym for a "bee-line"—otherwise a straight line, cross-country. But aviators have been doing some observing, says American Airways; and they find that, while ducks and geese travel straight, the crow can't keep a straight line for more than a minute, and is evidently not equipped with a gyroscopic compass, radio beacon, or other direction finder.

Magnesium Creates Vegetable Food

■ CHLOROPHYLL, the substance in the leaves of plants which converts water, air and sunshine into carbohydrates (sugar and starch) and thereby feeds, directly or indirectly, the human race, depends on magnesium for its activity, says Professor Richard Willstaetter, Nobel prize winner. The magnesium in the chlorophyll is a *catalyst*—that is, it brings about chemical action without being itself used up. A similar purpose is played by iron in plants, as in the blood of animals; it assists the processes of oxidation, and the production thereby of vital heat and energy.

Read with Closed Eyes by X-Rays

■ IN absolute darkness, X-rays can be detected by the eyes—not directly, but from the secondary radiation or *fluorescence* they cause inside the eye itself. Dr. A. H. Pirie, of Montreal, has constructed an apparatus by which the patient may see and locate a foreign body inside his own eye; he can thus determine whether the optic nerve is still active, in case of a cataract or tumor closing the eye, and thereby the possible success of an operation. With this apparatus, it is possible to read metal letters with the eyes tightly closed.

How Old is the Earth?

■ A WELL-KNOWN account of the earth's being made before sun, moon and stars is perhaps rather old-fashioned; but Sir Arthur Eddington has remarked on the peculiar fact that the earth, according to the geologists, seems to be older than all the rest of the universe, according to astronomers. The jigsaw puzzle does not fit together. However, the attention of the astronomers has been called by Miss Clark, of Johns Hopkins, to the consideration that, if the nebulas we now see exploding outward are at a distance of 150,000,000 light-years, we see them only as they were before the past 150,000,000 years. They may in the meantime have changed their direction, and started coming back toward us. In other words, nobody knows where the universe is, or what it is doing, right now.

Births Usually at Night

■ A SWISS physician, Dr. Edouard Jenny, has analyzed the birth and death reports of that country, by the hours of the happenings. The death rate seemed to have two peaks, one around nightfall, and one in the morning. Seagoing people have a belief that deaths "go out with the tide;" but this influence is hardly to be found in the mountains. As for births however, the greatest number of cases are reported as having taken place at night; increasing rapidly toward midnight, and becoming highest between two and five o'clock in the morning—the same time when deaths are also at maximum. It is suggested that some unknown natural phenomenon affecting human vitality may be involved.

More Inland Seaways

■ THREE ship canals across the island of Great Britain, it has been suggested, are necessary to take the place of the English Channel, in case of another World War. These waterways would connect the rivers Clyde, and Forth, in Scotland; the Tyne and the Solway, across the top of England; and the Mersey and the Humber, across the middle of England; and be navigable by sea-going ships. A ship canal was cut through northern Scotland, many years ago; and there is another through the Isthmus of Corinth in Greece, while the Kiel Canal in Germany runs from the North Sea to the Baltic.

Starting the Heart Again

■ A HEART which had stopped while an operation for appendicitis was being performed, at the London (England) Hospital, was started again by the physicians eleven times, according to the official report. The drugs *coramine* and *lobeline* were injected into the organ, and massage was applied to it. It was, however, impossible to obtain continued action; and finally the fact of death was acknowledged.

Smelling Out Oil Wells

■ SLIGHT though the quantity of petroleum gases that can get up through solid rocks, it is nevertheless comparable with the amount of gas that a piece of uranium gives off while it is decomposing. Two Russian chemists who had been working on radioactivity, Sobolov and Gurevich, are said to have applied this method of detecting very small emanations to prospecting, without drilling, in the oil fields of Baku. The gas in a hole three feet deep is tested by chemical "smelling."

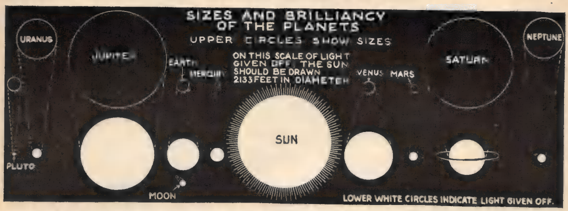

SIZES AND BRILLIANCY OF THE PLANETS
UPPER CIRCLES SHOW SIZES
URANUS
JUPITER
EARTH
MERCURY
ON THIS SCALE OF LIGHT GIVEN OFF THE SUN SHOULD BE DRAWN 2133 FEET IN DIAMETER
VENUS
MARS
SATURN
NEPTUNE
SUN
PLUTO
MOON
LOWER WHITE CIRCLES INDICATE LIGHT GIVEN OFF.

Fig. 1—Above, [redacted] comparative sizes of the planets; and, below, their brightnesses [redacted] by [redacted] observer so far away that they appear at practically [redacted] distance. Jupiter is [redacted] bit small, as shown; and the comparative diameter of the Sun would be 14 inches; while his brightness is completely beyond the reach of representation. On this scale, the distance of the Earth from the Sun [redacted] 125 feet, and that of Pluto about [redacted] mile. However, since Venus is much closer to us, she looks far brighter than Jupiter.

How to Know the Planets

● EVERY reader of scientific facts and scientific fiction keeps hearing of the planets, but it is seldom that any information is published as to where they may be seen with the naked eye. In fact, we have seen a gentleman who had written several interesting novels, about life on Jupiter, gazing interestedly at that planet and asking blandly: "Is that Venus?" So it is no wonder that our readers keep writing in to ask for information about the planets, and where to look for them in the sky.

The answer must necessarily be [redacted] long one, for the planets do not "stay put." The "fixed stars" rise at regular times, and are in the same place at the corresponding days and hours of every year. But the planets are vagabonds, as the original meaning of the word implies. Jupiter and Venus, it is true, are hard to mistake for other bodies, because of their great brilliancy; but there are many stars which look to the eye much the same as do Mercury, Mars and Saturn.

The diagrams accompanying this article show the positions in the sky, during the last three months of this year, of the five planets which are visible to the naked eye, and their positions in their orbits, [redacted] regards the Earth. It will be noted that the planets follow fairly regular paths in the heavens and, in fact, they run very closely in the track of the Sun —which is called the Ecliptic. If we were able to see the stars around the Sun in the daytime, the study of astronomy would be much easier for the beginner. As it is, he must take this fact for granted: that the Sun has a regular route.

If [redacted] star or [redacted] planet is sufficiently far *east* of the Sun, it becomes visible when night sets in. Taking Nov. 15 as our date, we find that the planets Mars, Venus and Saturn are in this position (Fig. 2). Venus is conspicuously brilliant for nearly four hours after sunset.

Mars is not very bright, and sets very early. A month ago, it would have been much easier to pick him out, and compare him with the bright nearby star *Antares*, which is said to look just like him. (Fig. 3)

Mercury is the hardest of the five planets to see with the eye; he always sets [redacted] little while after the Sun, and can be picked out best in southern latitudes. On Nov. 15, however, Mercury is quite invisible, even with [redacted] telescope, being almost directly in front of the Sun. A couple of weeks will elapse before he comes out of the glare as [redacted] morning star, *west* of the Sun.

Jupiter passed behind the Sun on September 27; and is now visible in the eastern sky, just before sunrise.

(*Continued on page 908*)

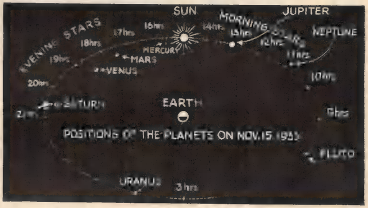


Fig. 2—The oval line represents the Ecliptic, or path of the Sun through the starry heavens, during the year. The "hours" [redacted] those marked on a star map, and represent longitudes in the sky. However, since the sky turns, as if the Sun revolved around the Earth every day, the planets [redacted] to [redacted] with it; the difference in hours shows how long before or after the Sun each planet sets. The right side of the diagram represents the west; the left side, the east.

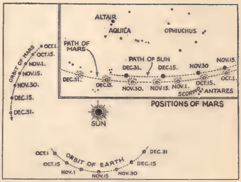


Fig. 3—Above, the apparent movements of Mars and the Sun in the sky, [redacted] seen from the Earth; with the two brightest stars, Antares and Altair, and [redacted] smaller fixed stars of the constellations named. Below, the actual motions of Mars and the Earth, causing the appearances above, for the three-month period.

Oscar Johnson at work on the machine he designed to turn out his patented door checks.

Modern Money

How to Make Money From These Plans

The first thing to do, when attempting to make commercial use of the plans here given, is to determine where the most likely market appears. This may be a private home owner, a drink parlor, an office or, in general, any store catering to the electrical, or novelty trade.

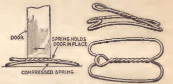
The next thing is to try to make use of the material available; construct one of the many designs given; and with this, go out to try to get orders. Notify prospective purchasers that the articles will be made in any finish desired; because the products are not "mass production" but worked up to the individual's order. However, when you make up your cost sheets, be sure to charge for the material as if it were new; since it may be necessary to purchase more stock, and you may not always find it in the junk heap. You should add at least 50 cents per hour for your labor charge, and then the finished product should bring at least three times its actual cost; but, if you have made a very fine piece, you may be able to get even more for the finished job. Lastly, when fixing your charges, the purchaser's pocketbook may be considered. If he has money, he will not object to paying much more for a splendidly-finished article, of brass and stainless steel.

Builds His Own Wire Bending and Shaping Machinery to Exploit His Own Invention

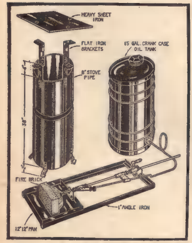
■ HERE is a short-short story of how a man who had an idea managed to get recognition of the merits of his invention, and how he was able to sell his product; even though he found it necessary to build his own machinery for its manufacture, which he undertook for himself.

Oscar Johnson, of Verdugo City, California, secured a patent on a door check —a small, simple wire device designed to hold doors open. The construction of the article is absurdly easy. The profit from the sales is good; but it is often difficult to find a manufacturer who is willing to undertake the construction of such articles, or to purchase patent rights. Mr. Johnson, however, had implicit faith in his invention. He felt that it would go over, if it were available to the public at large; but the product had to be made simply and cheaply. So, because there was no machinery available for its manufacture, the inventor worked out his own design of a machine with which he is able to turn out stops in a quantity great enough to take care of the local demand. Three operations are necessary on his home-made machine.

The small wire form, after being twisted, is given a lacquer finish. Only 2½" long, this little gadget can be shoved under the door by the foot of the housewife, which presses it down and allows the bottom of the door to ride over the twisted spring portion. The stop is now released, and the door is held in place. Should it be necessary to close the door, the housewife need not stoop to release the stop, but again steps on it, and the door swings free. It is safe, sanitary, practically indestructible, and cannot mar hardwood floors.



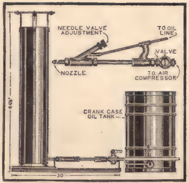
This article, which holds refractory doors open, is turned out quickly on the machine illustrated at the top of this column.



Assembly of the garage shop heater, illustrating how the brick is set in position before the flame, and details of the metal heater. The flame is started with paper or oily rags.

Heater Burns Crankcase Oil

● IT costs practically nothing to feed this easily-made shop heater, because the fuel is waste oil drained from crankcases and fed under air pressure through an adjustable nozzle.



Used crankcase oil is the fuel for this heater; air is supplied by the regular air compressor with which every garage is equipped. Burner details are given above.

In the original job, illustrated here, the nozzle was taken from an old spring sprayer; but a similar device could be made in the shop. Of course, a regular shop air-compressor is a necessary part of the apparatus; but, so far as operating expense goes, the amount of air used is negligible.

Construction of the nozzle is illustrated in the drawing. Note the air shut-off valve, and the air and oil streams converging in the adjustable needle-valve chamber.

The oil line is supplied from a drum, and the air line is connected direct to the compressor tank. The heater is merely a length of stove pipe of large diameter, with a cap to diffuse the heat, and spread-out legs to give it stability. It sits in a large shallow pan, so that oil will not mess the floor while adjustment is being made. The pan, in turn,

(Continued on page 912)

Making Novelties

Combination Smoker's Stand and Magazine Rack

HERE is a convenient smoker's table which the average owner of a small workshop can build in a reasonably short time, and which, if properly finished, should command a fair sale. Made entirely of oak, it will give a lasting service. It should be either finished in natural oak or stained dark and polished.

The magazine table is shown assembled in Fig. 1; details for its construction are given at the bottom of this page. The divisions of the rack are cut from ¼" oak plywood with a fret saw. Lay out and shape the bottom as shown in the middle illustration of Fig. 3. Then lay out two inner divisions as shown at the top of Fig. 3, and two outer panels as illustrated at the bottom of Fig. 3. Use a compass to mark the circles, placing the center of the compass at the position indicated by the diagonal arrows.

The column support is 21" x 1⅜" x ⅞". A hole is drilled in the bottom for the insertion of a dowel, and a corresponding hole drilled in the center of the plywood base. To hold the circular ashtray at the top, a similar dowel is inserted into the shaft.

The ash tray should be 8⅞" in diameter, made of oak and turned out on a lathe. Two suitable brackets, 2½" x 1¼" x ⅝", are fitted to the sides of the column for additional support. They should be doweled in position, as indicated in Fig. 4. Use any design in keeping with the general lines of the construction.

The inner divisions of the bookrack on the face of the tray are fixed, one on each side of the upright. The bottom is glued and nailed with small brads driven in from underneath to the inner divisions. The outer divisions are similarly nailed and glued; but allowance is made for outer brackets which measure 3½" x 1⅝" x ⅝". To cover the edges of the plywood and form an ornamental finish, it is advisable to glue and nail half-round turned moulding around the edges of the divisions and around the bottom. Two feet of oak, 10" x 2" x 1", resembling the form illustrated in Fig. 2, are fixed to the bottom to provide a wide firm bearing. After the work has been finished, it is suggested that suitable fittings be added to hold a box of matches; a tray of any form may be placed in the center of the turned wooden top for cigarettes.

The present construction will hold

(Continued on page 923)

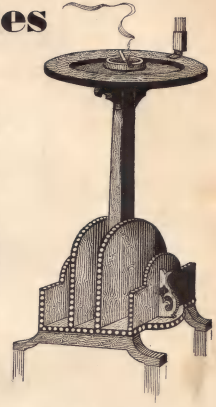


Fig. 1—If they are well made, you should be able to sell quite a few of these smoking stands.

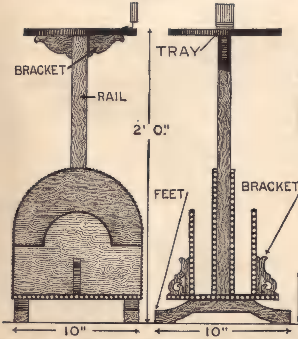


Fig. 2—Front and side views of the combination smoking stand and magazine rack, giving principal dimensions.

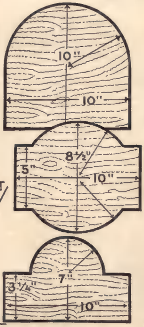


Fig. 3—Dimensions of center, bottom and end pieces.

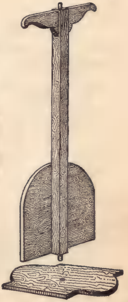
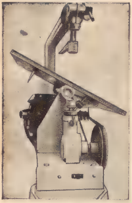
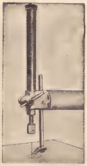


Fig. 4—Showing how the standard is made.

Awards in the $500.00



Front view of the first prize-winning entry.



Close-up view of the upper head, showing mounting of foot and upper spring.

PRIZE WINNERS IN THIS MONTH'S CONTEST

FIRST PRIZE—$15.00
B. N. Seibert, Ft. Collins, Colo.

SECOND PRIZE—$5.00
Victor Jann, Los Angeles, Calif.

THIRD PRIZE—$3.00
E. Symons, Rocanville, Saskatchewan

FOURTH PRIZE—$2.00
Karl E. Schott, Yuma, Arizona

FIFTH PRIZE—$2.00
M. Lenz, Newark, N. J.

SIXTH PRIZE—$2.00
Mortimer Max, Hastings, Nebraska

SEVENTH PRIZE—$2.00
Victor Jann, Los Angeles, Calif.

EIGHTH PRIZE—$2.00
Floyd H. Brooks, Pine City, N. Y.

NINTH PRIZE—$2.00
Leonard Stuart, Jr., Lexington, Nebraska

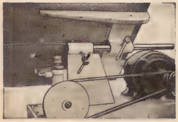


Table tilted to show bottom construction. (See additional photo on [illegible] 864)

First Prize—Jig-Saw

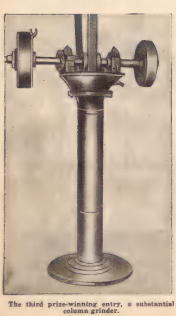
● THE frame of this jig-saw is a piece of channel iron taken from ■ Chevrolet, 30" long; with two pieces of driveshaft housing from a Ford, one 17" long and the other 23" long, welded together at right angles, and then to the base. The table support is a piece of 1/8" boiler plate, welded to the channel 4" from the front; with a similar piece welded at the left of this upright for stiffening. A 3" bushing is welded on top of the table support (obtained from a truck spring).

The head for the upper spring housing was shaped from a piece of 2 1/4" x 4" shafting. A shoulder was first turned to fit the driveshaft housing of the frame; then two holes were bored through the shafting, one 1/2", and the other 1 1/8". They must be in line. Split the front with a hacksaw so that ■ bolt can be passed through it for squeezing down on the spring housing. The smaller hole is for the hold-down rod (made from ■ piece of brake rod); and the foot is made from 1/4" x 1" x 2" iron, case-hardened. Provide ■ thumbscrew for locking. The spring housing is made from a piece of steering-rod housing (Chevrolet) 11" long, and a piece of square stock 3/8" x 10". Two bushings are needed, one fastened to the housing and the other to the square rod. Turn the bushings out as one piece, and square the hole with a file; then drive the square stock through to a tight fit, cut in half, and you will have two bushings. Any brake spring is used on the top.

The lower assembly is made from an auto compressor with a 1/2" x 3 1/2" rod brazed to the exact center of the piston. Bore the valve seat out to take ■ Ford spindle bushing for a tight fit, and bolt the compressor directly under the upper chuck.

The table frame is made of angle iron and the other truck bushing welded to the cross piece. This slides on ■ rod

(Continued on page 907)



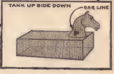
The third prize-winning entry, ■ substantial column grinder.

Column Grinder

● A VERY substantial column grinder, suitable for shop use was made from discarded auto parts. The upper part is made from ■ 1924 Essex rear end, ring gear and pinions removed. The base is an old Ford flywheel, threaded on a lathe. A piece of 4" pipe was cut and threaded on the inside to fit the flywheel. The upper part is fitted into ■ pipe and brazed. The shaft for the grinding and buffing wheels is made out of 1 1/2" cold rolled steel, turned on a lathe to fit whatever roller bearings are available. If adjustable bearings are provided, any wear can be taken up. Suitable covers are fitted to protect bearings from emery dust and grit, and on either side of the bearing a piece of felt is mounted. The only additional requirement is the addition of oil or grease cups, readily obtained from any store. —*Victor Jann.*

Bucking Gas Tank

You can have ■ lot of sport with ■ gasoline tank converted into ■ water hobby - horse. This suggestion was awarded ninth prize.



Mount a wooden horse's head over the petcock of the gas tank; then try to straddle it in the water.

Old Auto Parts Contest

Second Prize—Flexible Shaft Grinder

THIS utilizes an old speedometer-shaft casing; ball-bearing assemblies from an old generator; two pieces of steel tubing from an old steering-column shaft; and four Ford "T" connecting rods.

Driving end is built up from old rods, as shown, which makes a convenient provision for belt tightening. Flexible shaft housing encases a length of wire rope, 5/16" diameter, fitted with a floating spline at either end to compensate for "weaving" tendency of wire-rope drive; and keyways are cut in the driving and driven shafts to accommodate these splines.

Grinder head is built up from a length of the same tubing, with bosses machined to fit either end, and carry ball bearings for arbor; these bosses being either threaded or force-fitted to tubing; and bearings retained by threaded retainers. Threaded bosses are threaded to each end, to accommodate coupling unions on casing.—*E. Symons.*

Gear Reduction for Freezer

AN ice-cream freezer, which holds half a gallon of finished ice cream or sherbet, was driven by a 1/4-horsepower motor through a gear reduction obtained from an Essex-4 steering gear. The ice cream is frozen in eight minutes or less. The universal joint is made from a fibre disc which fits on a Dodge-4 generator drive. The tub sits in an aluminum can, and the brine flows out through a valve in the front. The tub is held in place by rods and clips.—*Karl E. Schott.*

Automatic Pressure Switch

THIS cheap fixture will turn the air compressor's motor on and off, when the pressure desired has been reached. It is adjustable, cheap, and requires no attention. As illustrated elsewhere on this page, an elbow (5) is soldered to the end of an automobile tire air gauge. The gauge itself is soldered between the sides of a U-shaped brass piece (6). The switch is now set in an "On" position, and the toggle brought up against a sliding sleeve of the gauge. The switch is now soldered in place. A washer is put on the other side of the switch, and a spring then inserted. Another washer added at the end of the spring, and a piece of square brass is threaded, then soldered into the end of the tube; finally, the adjustment screw (4) is inserted in the end. When pressure in the tank pushes the gauge out, the toggle switch opens the circuit to the motor. When pressure falls, the spring pushes the switch in the opposite direction. Variations from 5 to 50 pounds are possible.—*M. Lenz.*

Important Announcement

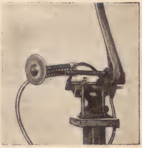
The next issue will contain the list of winners of the

GRAND PRIZES

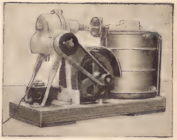
in the

Old Auto Parts Contest

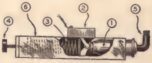
Further uses of old auto parts will be published periodically and payment will be made in accordance with our regular rates.



SECOND PRIZE
Description of this flexible shaft grinder is given in the text on this page.



FOURTH PRIZE
This ice cream freezer was driven through a reduction gear obtained from an Essex 4 steering gear.



AUTOMATIC AIR SWITCH

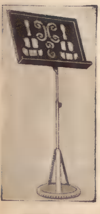
FIFTH PRIZE
An ideal switch for the paint spraying outfit. 1—tire gauge; 2—radio toggle switch; 3—spring; 4—thumb screw for pressure adjustment; 5—gasoline tank elbow; 6—U-shaped piece of brass.

Auto Parts Music Stand

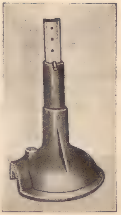
THE base is made from a ring gear, with a thin metal disc bolted on the inside. The uprights are two pipes which slide in each other, the outer one fitted with a setscrew. Strap-iron braces at the bottom, and a wooden frame with cardboard serves for the top.—*Floyd H. Brooks.*

An Adjustable Stand

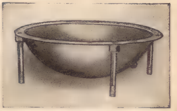
THE stand illustrated in the photo at the right was made from an old differential housing, a piece of pipe drilled with holes, and a pin. It is very convenient for holding long work in hacksaw or drill press, or to hold a car after it has been jacked up. —*Mortimer Max.*



EIGHTH PRIZE
A simple music stand.



SIXTH PRIZE
An excellent stand for shop or garage



SEVENTH PRIZE
For washing machine parts with gasoline, [illegible] a pan made from an Essex rear end differential cover with legs from studs from the cylinder block—Victor Jann.

New Tools You Can Easily Make

Combination Vee-Block Vise

WHILE the vee-block is of unquestionable value in drilling into round metal rods, for more precise work, it is only too frequently required to maintain the block more rigidly on the drill-press table. Then the clamping screw of the average vee-block yoke is often in the path of the drill chuck. An inspection of the tool shown in Fig. 1 will reveal that, in effect, two vee-blocks are available which may be separated; each is equipped with a compact and efficient type of clamp strap. This peculiar and extremely useful improvisation is a combination of vise and vee-block: it is made by drilling and tapping a pair of holes, and filing a vee in each jaw of the vise. A better grade of vise is recommended for this purpose, since much of its practicality depends on the accuracy of its sides with relation to the base.

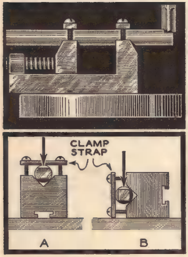


Fig. 2—Showing how the combination vee-block vise is used on the drill-press table for milling.

The manner of converting the vise is quite simple and obvious from the illustrations (Fig. 1 and Fig. 2). Before filing the 90° vee slots, make certain that the movable jaw is perfectly aligned against its mate, then tighten the screw firmly. Lay out the vee accurately, make a single saw cut (as straight and as square to the jaw tops as possible) down to the apex or root of the vee; then remove the triangular bit of metal on each side of the saw cut by either filing or sawing. Lay a long length of square steel rod in the semi-finished vee slot, and determine whether the slot is parallel to the vise base. Correct by filing the slot accordingly.

Completing the tool simply involves drilling and tapping holes for the clamp straps, and making these straps; and also removing the handle or "tommy bar" from the vise clamping screw. Drill an additional cross hole through the clamping-screw head.

The number and variety of operations possible on this new tool are amazing—many of them are not practical on either a vise or vee-block alone. As indicated in Fig. 2, it is possible even to do a certain amount of simple milling. The end of a shaft or rod is either flattened or completely squared as follows: clamp the vise to the drill-press table, so that the angle of the vee slot is aligned with the center of the spindle. Separate the jaws and clamp the work under the two clamp straps. Mill the end of the rod, with an end mill, to the required depth, then loosen the clamp strap on the fixed jaw and advance the work further by turning the vise screw. Reclamp the fixed jaw strap and continue to mill. Note that, while milling, both straps are tightened and that the fixed jaw strap is only opened when feeding. After milling another flat opposite the first one (A, Fig. 2), successively turn, and reclamp the vise on its sides as at B for the other flats.

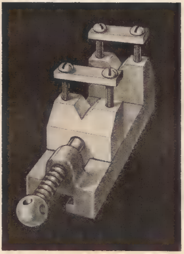


Fig. 1—The manner of converting the vise is clearly illustrated in the picture above.

Ball Drilling Clamp Tool

THE simple clamping tool illustrated in Fig. 3 has been designed to solve one of the most difficult clamping problems in the amateur machine shop—that of securely holding a metal ball without scoring it, so that a hole can be drilled centrally through it. Conventional clamps, vises and chucks do not offer a sufficient or properly shaped surface; nor are other fixtures, intended for this function, ordinarily available.

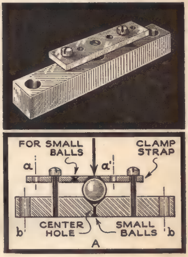


Fig. 3—This simple tool will hold balls on the faceplate, and permit them to be centrally drilled.

The device, Fig. 3, consists of only two simple bars and two clamping screws. Two ranges of ball diameters are accommodated by drilling two pairs of 45° countersunk holes in the bars; although, for individual requirements, one pair might be sufficient.

The lower heavier bar, A, is the base, and it is secured to the lathe faceplate, or drill-press table, by means of screws through holes b, b^1. A 1/16" center hole is drilled into the base; one opening of which is countersunk at 45° to hold a large ball (as shown), and the

(Cont'd on page 923)

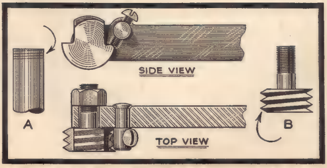


Fig. 4—An ideal threading tool which almost automatically sets itself.

RADIO WRINKLES

By Our Readers

Send in your ideas, if they [illegible] taken from your own experience, for the benefit of other radio fans. A rough sketch will do if it makes the idea clear; our artists will work it up. Published kinks will be paid for at the rate of $2.00 each. Address the Wrinkles Editor.

Short-Wave Plug-In Coils

IN making efficient short-wave coils, especially for the ultra-short waves, the idea presented in Fig. 1 will be found helpful.

A tube base is used for plugging into the coil socket. The wire used should be fairly heavy; No. 14 has been found to serve very well, and is very easy to handle. The coil is wound to small diameter, using [illegible] small metal or wooden tube, or rod, to give it the proper shape; after which the coil is removed, inserted in the tube base and soldered in place. —*E. H. Fisel.*

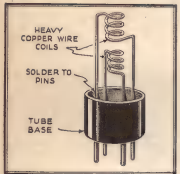


Fig. 1—These small, self-supporting coils [illegible] low-loss, and can be handled without injury.

Temporary Layout Chassis

FELLOW experimenter and set builder, here is a new one; and it is not [illegible] bird-cage, either. A dime's worth of quarter-inch mesh hardware-cloth, a pair of tin-snips and you are well on the way to make a dummy chassis for laying out any circuit which you might wish to build.

Referring to Fig. 2 which represents [illegible] corner section of the dummy chassis, you will notice that the parts may be temporarily bolted to the dummy; so that you may determine the best location for each component, and the shortest path for the wiring. It will also serve as a guide to lay out the plans of the permanent chassis; by counting the one-fourth inch squares from any desired point.—*Arthur J. Abrahamson.*

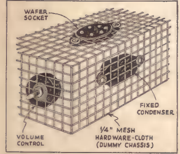


Fig. 2—The wire screen permits the whole kit to be laid out, for best results, before cutting the metal for chassis or case.

Use of 25-Cycle Sets

MANY 25-cycle receivers, when used on 60-cycle current, operate at greatly reduced volume. Tests of the various set voltages show that they are all somewhat higher, when used on [illegible] line-frequency which is higher than that for which the power transformer has been designed. The detector is affected more than any other stage by this increase in voltage.

A 4000-ohm "bleeder" resistor (R, in Fig. 3) placed between the detector plate supply and ground (chassis) usually corrects this satisfactorily.

Many 25-cycle power transformers are overloaded when used on 60-cycle current. The use of type 56 tubes, in place of the type 27, reduces some of this overload. The socket connections are identical.—*Willis Judd.*

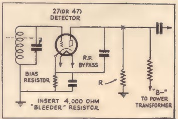

27(OR 47) DETECTOR
R.F. BYPASS
BIAS RESISTOR
R
INSERT 4,000 OHM "BLEEDER" RESISTOR
"B–" TO POWER TRANSFORMER

Fig. 3—The resistor [illegible] lowers the detector's plate voltage, and thereby restores [illegible] proper functioning.

Finding Trouble in a Set

WITHOUT other testing apparatus, a lamp in series with [illegible] radio set's power cord will often serve to shoot trouble. For instance, when a set blows the lighting fuse, there is perhaps a shorted tube, or transformer. If the series lamp lights, with all tubes out, there is [illegible] short in the transformer or filter condensers. If not, put in the tubes, one at [illegible] time; when the lamp lights, the bad tube is spotted.

Screen Grid Receiver Adjustment

SOME screen-grid sets have poorer tone when the volume control is near the minimum position but, unless the volume is cut down, powerful stations are too loud for comfort. In such cases, lifting the cap from the top of the first tube (Fig. 4) lessens the coupling (now capacitative) between the antenna circuit and the R. F. stage. The volume control may then be turned up to normal position, with better tone quality. For distant stations the cap is replaced.

This does not injure the set and is done quickly without tools.—*Charles Latour, Jr.*

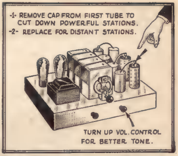

-1- REMOVE CAP FROM FIRST TUBE TO CUT DOWN POWERFUL STATIONS.
-2- REPLACE FOR DISTANT STATIONS.
TURN UP VOL. CONTROL FOR BETTER TONE.

Fig. 4—With the [illegible] amplification of [illegible] modern set, reception may be had this way. Or connection may be made to the second or third tube's cap.

Useful Drilling Tool

EVERY experimenter is, or has been confronted by the problem of how to drill tube holes in a chassis; I solved mine with [illegible] discarded auger bit. The tool (Fig. 5) is made by simply grinding off the cutting knife of the bit; and you have [illegible] chassis and panel drill.

To operate the drill is also very simple. A small center hole is drilled into the chassis, where the socket is to be, to admit the guide of the bit; the bit is placed in a hand brace and, in a few seconds, a neat round hole is drilled in the chassis.—*Melvin J. Weiland.*

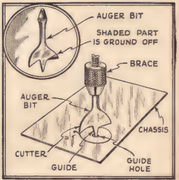


Fig. 5—Easy [illegible] cut soft metal, rubber [illegible] bakelite.

A. C. Measuring Instruments

Building Instruments for Measuring Voltage, Amperes, Henries, Microfarads and Watts

■ THE construction of electrical measuring instruments is illustrated in the five sketches of Fig. 1. The pointer is cut from white pine; it is 6" long, ¼" wide, and tapers in thickness from 1/16" to the thinness of paper at the free end. One inch up from the thick end, there is inserted a half-inch length of steel, broken from a fine sewing needle, which serves as the shaft or spindle. With pliers, this needle is forced into the wood; the wood being gripped firmly in a vise. The wide end of the pointer is then weighted to remain vertical, by wrapping a copper strip or wire about it. Finally, to complete the balance, a strip of soft sheet iron, cut as shown in Fig. 1-A, is forced into the wood. The size is best found by experiment; keep it small: if it is too heavy it will pull the needle too far to one side of the scale, and its greater mass will keep the needle swinging longer before coming to rest.

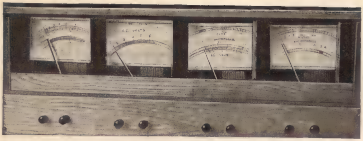


Fig. 3—The construction of these electrical measuring instruments is explained in the text. The first meter at the left is calibrated in henries, ohms, amperes and watts. The second measures A.C. volts; the third, ohms to 10,000, microfarads from .05 to 0.5, and volts to 110; while the meter at the right measures ohms to 1000 and microfarads from 0.5 to 4.0.

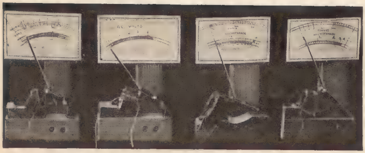


Fig. 4—In this photo, the meters are shown without the panel mounting. If desired, the builder may make individual boxes for each instrument.

The best size for the plunger was found to be 1/8" long and 1/8" wide at the center to 1/16" at the ends. The iron can be cut from a strip of the core of an old transformer, from a piece of stovepipe iron, or from a tin can.

A piece of sheet copper or aluminum is needed as the support for the needle; its shape being shown in Fig. 1-B. The coil, Fig. 1-C, should be inclined to an angle of 30 degrees from the horizontal; which is readily done by cutting the wooden frame as shown in Fig. 1-D. Details of the assembly are given in Fig. 2. Photos of these constructions are reproduced in Figs. 3 and 4.

Elementary experiments in electricity are best performed "breadboard style"; that it is to say, the instruments are scattered on a table. For more advanced research, mount meters on a panel.

A D.C. ohmmeter, made according to the scheme of Fig. 5, is simply an electromagnetic scale; the pull on the plunger makes the needle indicate the value of some unknown resistance inserted in series in the meter and battery circuit. The same series connection is used for finding inductance and capacity values over a limited range; but here we shall require *alternating* current supply, in place of a battery, and its frequency (60 cycles) must always remain the same.

If, using the scheme of Fig. 5, the scale is calibrated for a purely resistive (ohmic) variation, and if the resistance of the meter's coil is known, the scale can be calibrated for flow of current in amperes. Then, by reference to the values of henries-microfarads-amperes

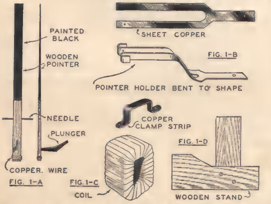


Fig. 1—This diagram gives all of the details needed for the construction of the electrical measuring instruments described in the text.

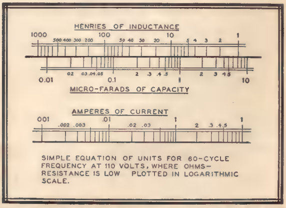


Fig. 6—Showing how the scales are arranged. A final check should be made by comparing the actual meter readings with a set of standards.

Easily Made

By ESTEN MOEN

given in Fig. 6, a rough idea of the working range of the instrument may be immediately obtained. But actually the solution is not so simple; because the natural *inductance*, combined with the resistance, in the meter coil, will displace these values from the normal. The final check on the meter is made by using known values of capacity inserted in the circuit of Fig. 5; in other words, by using about six wax-paper condensers, ranging from 0.1 to 2.0 mf. The corresponding points are found on the scale, and the whole scale is then drawn by approximation.

The coil of the wattmeter, at the left in Figs. 3 and 4, contains 70 feet of No. 24 enameled wire wound on a form one inch in diameter; the needle then swings to full deflection at 2 amperes, and the meter will indicate, on 110-volt current, up to 220 watts, which is sufficient for checking the working load on lamps, radios, small fan motors, etc.

The voltmeter (second from left, Figs. 3 and 4) contains a coil of 100 feet of No. 30 cotton-covered wire. Its natural resistance is ten ohms, and at five volts it passes half an ampere. This meter then indicates A.C. voltages from 1 to 5 volts; making it suitable for testing the filament voltages on sockets of A.C. radios.

The third meter from the left, Figs. 3 and 4, has a coil which was once the secondary of an audio transformer (a Kolster). The primary, which had been circuited, was cut out with a knife. Now, this secondary of over 10,000 ohms D.C. resistance has quite a high A.C. impedance; which means that its best operation is over a capacity range between 0.05 and 0.5-microfarad. Suppose this instrument is used as a voltmeter, and that its maximum deflection (for 110 volts) is 25 degrees. When it is used as a *capacity* meter on 110 volts, it will be found that the maximum deflection will go up to 28 or 30 degrees, for a capacity of 1.0 microfarad, and will drop back to 25 degrees for capacity values greater than 1.0 microfarad.

The larger the coil (more turns

(Continued on page 907)

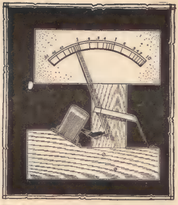


Fig. 2—Presenting the assembly of a meter. All the meters are substantially alike, except for the coils.

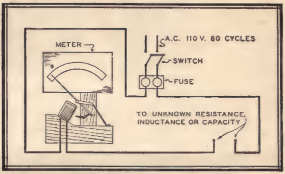


Fig. 5—Diagram showing circuit used for measurements.

Simple Synchronous A. C. Motor

By GEORGE A. SMITH

● A VERY simple and interesting little synchronous motor can be made as shown in the illustrations. The parts are made from scrap material which is not difficult to obtain.

The frame for holding the coil and one end of the rotating part is made from a piece of brass about 3/32" thick, and large enough to saw out with a hacksaw a strip ⅝" wide and 5" long. The electromagnet is of the spool type, with a tapped hole in one end, for attaching the coil to the frame with a screw. A coil of this type may be salvaged from any of a variety of electrical instruments. The rotating member is made up from old alarm-clock parts. A clock wheel is carefully removed from the brass collar that attaches it to the steel pinion. The wheel is discarded, and the steel pinion with the brass collar in place is used to make an accurate shaft for holding the piece of clock spring. It is suggested that the hole be punched in a length of the spring before breaking it to the exact length required. Several attempts may be necessary before a hole is punched without breaking the spring. The hole should be punched slightly smaller than the size required, and then filed out to the exact size with a small rat-tail file; so that the piece of spring can be riveted on the brass collar in a manner similar to the clock wheel before it was

(Continued on page 918)

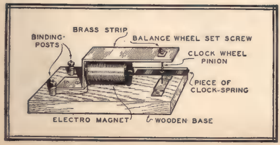


Diagram showing how the small synchronous motor is to be built.

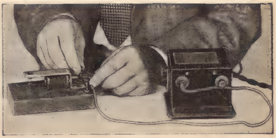


Photo of the motor being connected to transformer for test.

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SCIENCE FORUM

Save a Shave

Here's a "wrinkle" for the "shaving" fraternity:

The bathroom poet sings in glee, with face from care and whiskers free—But what it costs for blades! O, gee!

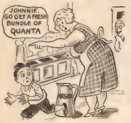
If you a two-edged razor use,
And the blades by chance abuse;
When in shaving there's a lull
Because the blades are awful dull—
Don't swear and rave,
Just go ahead and shave;
For all you need to do
Is multiply your blade by "two."
Place a blade upon the razor "bed,"
Another on this; then shave a(head).

This stunt works with my Gem Micromatic and, I feel sure, with other makes.

W. H. HAZEN,
Jennings, Louisiana.

(Thanks for the poetry, which is interesting, and we pass the information on to our readers for what it is worth. No doubt you saw described in our June issue a French razor which has, not only two blades, but five. We tried it, and frankly, our skin is a bit too light for the five blades. We have also tried the two-blade stunt and in turn we offer our improvement upon yours; and that is, take a third blade and carefully grind away the edges of this blade for about an eighth of an inch. This will give you a sort of shim, which is interposed between the two blades and separates them somewhat. We believe you will find the effect better. Of course, one blade on top of the other works too, but you may try our own stunt and see how it works for you. No beards are the same. Some people have tough skins and light beard; others with thin skin and a heavy beard must use an entirely different shaving technique.—Editor.)

Air-Conditioning with Quanta


JOHNNIE, GO GET A FRESH BUNDLE OF QUANTA
ARGON

It's the upkeep that counts

Your "prophetic powers" regarding "The Next Great Industry" which you refer to, viz., "just how far air-conditioning has developed" requires another guess.

Air-conditioning, as you know it, is on the way out. Because it lessens vitality. Vitality is not strengthened by applications of heat and cold, then cold and heat. "Hot and cold, cold and hot, just gets us ready for the burial plot."

Air-conditioning, of the future, must use "something" which consists of little bundles of quanta energy to bombard water. Water vapor is not the only thing essential to comfort of well-conditioned rooms. There must be made and used, all the vapors (gases) that go to make up the proper volumes of a "pure country air" and to obtain these you have to utilize the electron and the positron.

Apparently, when a quantum of energy strikes the nucleus of a hydrogen or oxygen atom there is a crumpling-up—a process of splitting-up. Part of the quantum is transformed into an electron, the rest is changed into a positron. These are the smallest known units of matter, the first having a negative electric charge, the second a positive charge. This process naturally produces heat, which is used to circulate the air of the room and at the same time dry the air; in other words, make the vapors (gases) keep them in motion. Water vapor is controlled by the nature of the device which changes by the "inertia of energy" on any element used.

Air-conditioning must increase your argon, helium, neon, krypton, and xenon water-vapor, and carbon dioxide must be manufactured. Every element must be maintained according to volume and there must be provisions for increasing the nitrogen, oxygen, water-vapor, and carbon dioxide if it becomes necessary. When the temperature outside runs to 100-120 degrees, the temperature must be raised inside so that the extreme will not be detrimental to the occupant's vitality. This is not a dream; the vision and blue-print stage has passed as the system is now going into the third season, heating in the winter and cooling in the summer.

FREDERIC R. HEWITT,
Elizabeth, N. J.

(We have carefully puzzled over the above, and pass it on to our readers for what it is worth. Air-conditioning is, as yet, in its infancy. There are many things still imperfectly understood, it is true; but you need not be unduly alarmed by staying indoors in an air-conditioned room with a temperature around 70 and then stepping out into the sun where it may be 90 or more. For health purposes, this is not different from stepping out from the heat of an apartment into the cold. And while abrupt changes from one temperature to another may, under certain circumstances, be unhealthful, the point should also be considered that it is certainly far from healthy to work all day long under humid conditions when the temperature is in the 90's. As a matter of fact, the wear and tear on the nervous system, and the health in general, undermines the human constitution a great deal and lowers the vitality. Of the two evils, we personally would choose the lesser—this being air-conditioning.—Editor.)

■ IN this department are printed letters from readers on various scientific and related topics.

It matters not whether your letter is complimentary or whether it is a brickbat, we will publish it just as readily. We want your comments—your opinions—on topics connected with this magazine. No attention will be paid to unsigned letters, nor are letters answered by mail. Worth-while letters are published here every month.

Address Editor, Science Forum, EVERYDAY SCIENCE AND MECHANICS, 100 Park Place, New York City.

Tesla Coils

I wish to take this opportunity of expressing my appreciation of your excellent magazine. There is none better.

Round turns and a fast belay

My hobby is electrical construction, especially that which involves the higher voltages and frequencies. Of course, I was delighted when the articles on the Tesla and Oudin coils appeared. I am still working on the construction of said coils. At home I have a fairly well-equipped lab, but here on board ship it is extremely difficult to accomplish anything. However, I am making the apparatus piece by piece and shipping it home where I can assemble it if I ever get back on leave.

CARL B. CAHILL,
U.S.S. "New York," Cal.

(Glad you like the article on the Tesla Coil. We have another article scheduled which will appear during the next two months. We have done quite a bit of experimenting with a radio vacuum-tube driven Tesla Coil which makes a spark coil unnecessary. We have obtained fair results, and we hope to make some improvements, to give you a real article along these lines real soon.—Editor.)

The Express Super-Liner

Although I am still in high school, I am an ardent reader of "Everyday Science and Mechanics." May I make a comment, or rather criticism, on a statement in the article "Express Super-Liner" in the October issue?

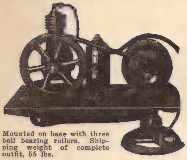
Another lump in Davy Jones' tea

Mr. Gernsback has certainly conceived a very practical project for the steamship line. He mentions the construction of such a ship might be of "aluminum composition" (on account of its lightness and strength) and later on asserts: "Nothing stands in the way, therefore, of building such a ship." There is, however, a very serious handicap which stands in the way, and I am afraid that these ships could operate on fresh water only because of the salt content of the ocean. The ship would literally dissolve in the solution; which is due to a peculiar property of aluminum, even in combination with other metals.

This phenomenon is due to the fact

(Continued on page 914)

Bargains For Home Craft Shops Electric Portable Sprayer Outfit



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This outfit comes completely equipped, nothing else to buy. It includes the following specifications: G-V full liquid pressure type adjustable gun. Non-clogging nozzle. Fan and round spray tips. 10" spread. ¼ H.P., 110 volt, 60 cycle AC motor. Air filter tank. Kellogg Air-Cooled Compressor, size 1¾x1¾, Connectors and 15 ft. hose, plug and cord.

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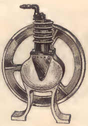

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1⅞x2	100 lbs.	600	¼ H.P.	[redacted]
2x2	125 lbs.	600	⅓ H.P.	[redacted]
2¼x2	175 lbs.	500	⅓ H.P.	[redacted]

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THE ORACLE

■ THIS technical question and answer department is conducted for the benefit of [redacted] readers; for this reason, only such questions [redacted] the editors believe are of interest to the majority will be published here. If reply is desired by mail, [redacted] charge of 50c per question is made, for such subjects, only, [redacted] do not require exhaustive research work or designing apparatus, or involve trade secrets.

Address all letters to the Oracle, care
EVERYDAY SCIENCE AND MECHANICS
100 Park Place, New York City

(127) Color of Sky and Sun

Why is the sky blue and the sun yellow, as [redacted] see them, when they say the sky looks black and the sun white when balloonists see them in the "stratosphere?" Is the sky ever absolutely black?

MATT J. MILLER,
Oklahoma City, Okla.

The sun, although a rather yellow star, as stars go, is nevertheless about the temperature of an electric arc; and its radiation includes a great deal of blue light, as well as deep violet and ultraviolet radiation. This is very intense, out in the open space between the planets. However, the earth and its atmosphere reflect about half the light which falls on them from the sun. The greater portion of the unreflected ultraviolet radiation is absorbed by the ozone of our upper atmosphere, fortunately for the human race, when we consider how quickly the little that gets through will cause sunburn and sunstroke. In the lower layers of the atmosphere, the many-colored rays of sunlight encounter molecules of gas, and finally dust. While the molecules are small, in proportion to even a wavelength of light (1/33,000" to 1/63,000") they have a certain scattering effect. The shorter, bluer, waves of light are more affected by this, and are diffused or deflected to various angles with their original path; while the red and yellow rays, which are longer, come through more directly.

So, when the sun is overhead, the least amount of radiation is deflected; the sun seems whiter—or, more correctly—bluer, because less blue light is lost in the sky. Clouds are whiter at noon. On the other hand, when the sun is setting, his rays come through nearly four hundred more miles of thin air; this deflects not only the blue, but even the yellow rays, and we see a blood-red sun on the horizon, surrounded by light red clouds. (See Fig. Q 127.)

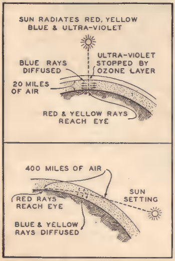
SUN RADIATES RED, YELLOW BLUE & ULTRA-VIOLET
ULTRA-VIOLET STOPPED BY OZONE LAYER
BLUE RAYS DIFFUSED
20 MILES OF AIR
RED & YELLOW RAYS REACH EYE
400 MILES OF AIR
SUN SETTING
RED RAYS REACH EYE
BLUE & YELLOW RAYS DIFFUSED

Fig. Q 127—Why the sun is red when setting; the air [redacted] as [redacted] color filter.

At a great height above the earth, where there is almost no deflection of light by the air, most of the rays from the sun come directly upon the observer, but almost none of the diffused light from the air, which is therefore invisible. In other words, one sees only vacancy, or blackness, where the blue sky seemed to be, when he looked from below.

It may be said that the atmosphere never seems to be absolutely dark. The radiation of sun and stars causes the molecules of air to give off considerable "secondary" radiation of their own. In addition to this, since light is recognized by a chemical action of the eye, and this always goes on to some extent, we never have a sensation of absolute darkness.

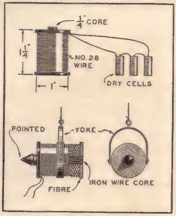

Fig. Q 129—Design of two electromagnets. The lower type is used for extracting bits of iron or steel from the eye.

(128) Electric Alarm System

I have heard of photoelectric cells being used to make burglar alarms that will work in the dark. Can I arrange a simpler alarm, without [redacted] photo cell, to operate electrically?

F. J. SALERNO,
Houston, Texas.

An absurdly simple alarm of the spring type, that you can use, is illustrated in Fig. Q 128. It will be observed that an ordinary safety pin is used as the spring. This is screwed fast to the board, and two small metal pieces are likewise fastened to the board, as shown. These metal pieces can be ordinary brass nails. The safety pin should also, preferably, be of brass or of the stainless type; a piece of string (preferably fish line) is tied to the pointed end of the pin, as shown; then run across the passage doorway, or zig-zag back and forth across the window frame on brads, as indicated by the dotted line. The far end of the string has a ring attached to it, to secure the end of the cord and hold the safety-pin contact in position, as shown in the diagram. The entire set-up is connected with the bell and battery.

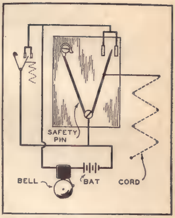

Fig. Q 128—A very simple form of electrical burglar alarm, which goes off by contact.

As many such units can be connected in parallel as are required to protect any door or any window. It will be observed that, the moment [redacted] person runs into the string, the point of the safety pin is pulled against one of the brads and the alarm rings. If the string is burned or broken, the point of the pin snaps against the inner contact and closes the circuit. In this form of construction, cutting the wires or jumping the safety pin over the inner contact will shut off the alarm.

The former weakness can be eliminated by using a three-wire circuit protected by relays, and popularly termed the "open-closed" system. Inserting a closed-circuit drop will prevent the alarm being shut off, after it has once been started, unless the drop is manually replaced.

In the daytime, when the apparatus is not in use, the string is released and the trigger jumped over the inner contact.

(129) Making Electromagnets

What are the dimensions of a strong magnet, made for battery operation? What kind of wire is used?

CHARLES BENNETT,
Los Angeles, California.

Wire of almost any size, wound on an iron core will produce an electro-

(Continued on page 913)

Breaking Up Tornadoes

(Continued from page 871)

second. **(See Note B)** The force of 2929.5 pounds per square inch is much more than the plank can withstand; the compressive strength of oak perpendicular to the grain being less than half of that. Evidently, then, an effect of this kind can be surely expected even with much smaller speed, especially if the stalk is pointed.

In this connection it is of interest to mention a classical experiment, which used to be shown to students in some European institutions of learning. It consisted in firing from a gun a tallow or stearin candle at a board 0.4-inch thick. To the amazement of the onlookers, the soft missile not only went through the wood but did not appear much worse for the experience. The secret of success was in the quickness of the transit, not giving enough time for the mass of the candle to yield. The obvious inference from such action is that an exposure to a windstorm is always fraught with danger to life; for bits of flying material, not excluding pieces of straw, may penetrate deeply into the flesh. If my memory serves me right, I have read of serious accidents of this sort.

But the highest air velocities observed in storms are not, in themselves, adequate to explain certain stupendous performances of the wind, such as lifting loaded cars and locomotives and hurling them to great distance. When I first read such reports, many years ago, they afforded me amusement as I took them for original American **canards,** often sprung on unsophisticated foreigners. When I found, to my unspeakable astonishment, that they were substantially true I endeavored again and again to prove them by theories and calculations; but it was only lately that I solved this long-standing riddle.

Whirling movements of the atmosphere have been known and dreaded since time immemorial, but, beyond accounts of their destructive actions, mostly uncertain, little positive information can be found about them. In 1862 was published by H. W. Dove an important work, entitled "The Law of Storms"; dealing chiefly with cyclones, which frequently extend over a large portion of the globe and travel thousands of miles before their energy is spent. These are easily studied and the chief facts concerning them are now well known. Not so the incomparably more dangerous **local storms, the real tornadoes,** which are sudden, erratic, ephemeral (short-lived) and extremely violent manifestations difficult to investigate.

Of late years the U. S. Weather Bureau and the Smithsonian Institution have been supplying data which are reliable and of value in connection with the subject; nevertheless, our knowledge of tornadoes is still fragmentary. Ignoring newspaper reports, which are not quite reliable, and confining myself to facts unmistakably established, I have come to certain conclusions regarding these phenomena, which might be important, and can be summarized as follows:

(1) The maximum velocity of the air forming the funnel probably never exceeds, say, 235 feet per second or about 160 miles an hour; which I think ample to explain all the actions observed. In his "Manual of Meteorology," an exhaustive treatise lately published, **Sir William Napier Shaw** makes the state-

(Continued on page 920)

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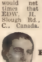

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PATENT ADVICE

Conducted by HUGO GERNSBACK

EVERY inventor, naturally, has his problems, and there [illegible] few inventors living who do not have to get professional advice at some time.

This department tries to be of service to all inventors, and would-be inventors, who are looking for advice on any patent phase. The reader should understand that [illegible] make it [illegible] rule not to answer patent questions free of charge; the large number of inquiries make this rule necessary. A selected number of [illegible] [illegible] published in this department, for the benefit of all concerned; but it is [illegible] rule to avoid giving out any important details. This is done to protect the inventor in all instances.

If you wish to get advice by mail, a standard charge of $1.00 is made for each question. If the question is such that it will necessitate [illegible] large amount of research work, the correspondent will be [illegible] informed, and the remittance returned to him.

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You may rest assured that any communication addressed to this department will be held in strict[illegible] confidence.

Buzzer Design

(185) Mr. Frank Neukliss, Tamaqua, Penna., submits a design for [illegible] new type of buzzer on which he asks the opinion of this department.

Answer: On examining your drawing and description, we do not seem to be able to find anything basically patentable.

Buzzers with adjustable tone control for operation on A.C. have been made for years, and the fact that they are not easily available on the market does not necessarily indicate that the product has not been patented. We do believe that your form of adjustment is probably a little different from the majority of those which have been produced, and which depend primarily upon placing the vibrating spring in tension to change the tone.

However, we do not believe that there is a great or favorable market for a buzzer with a variable tone control to operate on A.C., and we do not suggest further precedure.

Automobile Steering Gear

(186) Mr. E. F. Peppard, Minneapolis, Minn. submits plans for [illegible] new type of steering gear on which he desires advice as to patentability, and marketability.

Answer: We do not doubt that the idea which you advance for changing the steering gear of a car, so that two ratios will be obtained, is of some value.

Unfortunately, the most important part of this subject rests in your last inquiry, namely: whether car manufacturers would consider it feasible or desirable for adoption. Many inventors have had experience with car manufacturers heretofore. Hundreds of new ideas have been developed for the motor car industry, but very few of them have been successfully applied. This statement holds to a greater extent today than it did eight or ten years ago; when many an idea was converted into an accessory for automobiles, and as such enjoyed a limited sale. But the modern automobile enthusiast, the person who buys a car today, does not fit it with all sorts of devices and gadgets, and we do not believe that the present-day car owner would alter the steering gear, even if the last change could be effected by the substitution of but a relatively small part of the mechanism.

If you are in a position to gamble on this idea, and have the finances necessary for its proper production, and if the patent search reveals that you can basically cover the suggestion, it might be advisable for you to proceed further, and take a chance that some manufacturer in the automobile industry in the future will be willing to add this type of control to his automobile.

It is not, however, an idea for which you can expect an early sale.

Eye Lotion Bottle

(187) Mr. Burdette W. Livingstone, Clarksville, Michigan, creates a combination of eye lotion bottle and self-contained eye-cup on which he would like to secure [illegible] patent.

Answer: As nearly as we are able to determine, you are merely attempting to combine an eye-cup with a bottle to contain the eyewash; but if this is the case, you will find a much superior product in the form of a bottle containing an eye-cup, known as Collyrium. The stopper of this bottle is of glass, and the top of the stopper forms an eye-cup. No extra charge is made for the eye-cup accompanying the bottle, and the construction itself is much

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simpler than yours; while probably not as sanitary, it could be made so by the mere addition of a cap. There is one advantage in having the eye-cup open to the air, and that is that the user of the cup will always wash it out before filling it with the lotion.

It is not practicable to label one bottle "Right Eye" and the other "Left Eye," for the simple reason that bottles so labelled and so used take up too much shelf space, require additional original investment, and require the manipulation of two bottles to perform but a single operation.

We would suggest that you procure from your local druggist a bottle of the lotion mentioned above and examine the bottle and the stopper. We do not advocate further procedure with the present item.

Duplicating Machines

(188) Mr. L. R. Taylor of Laurel, Miss., has a particular type of duplicating machine in mind and wishes to become acquainted with the market for such a product.

Answer: It is extremely difficult for us to advise you as to the market for duplicating machines unless we know what kind of a duplicating machine you have in mind. Hundreds of different articles have been manufactured and sold for this purpose, but we are confident that if yours will do better work in any field and can be produced cheaply, you should find no difficulty in disposing of the article (not the patent), particularly in view of the present-day business expansion.

There are stencil-type machines which are operated like an ordinary rubber stamp; there is one which works on a roller, and still a third group, which picks up the duplicate from a hectograph pad. We presume however that you are familiar with the various articles on the market. We suggest that you have a search made on your new invention.

A. C. Meters

(Continued from page 899)

of wire) the smaller the capacity required to produce **resonance** (at a 60-cycle frequency), and, if a small coil is used, a larger condenser must be taken for resonance.

The coil of the meter at the extreme right, Figs. [illegible] and 4, was hand-wound from No. 40 enameled wire, and has a natural resistance of 1,000 ohms. Its capacity range is from 0.5 to 4.0 microfarads; if a greater capacity is used in series with this coil, it may burn out.

Review of Scientific Instruction Courses

■ **COURSE IN INDUSTRIAL MANAGEMENT, La Salle Extension University, Chicago, Ill. In Fifteen Parts. (Continued.)**

This course begins Vol. II with the principle of Measurement: first, with the question of standards, and then that of their application. The term "standards" is applied in a broad sense, and to a great many things beside production quota; and the warning is given that standardization has its natural boundaries, mental and physical. Here we reach that element in which executive ability plays the important part—Decision.

The seventh principle, Standard Conditions, deals with the personnel of an industrial institution, and falls under four heads: working conditions; physical fitness; mental fitness; and betterment of employees. Its recapitulation sets before the student executive the problem of controlling these. (To be continued.)

■ **COURSE IN MECHANICAL ENGINEERING, prepared by American School, Chicago, Ill. (Continued.)**

The processes producing his machinery must be considered by the engineer, a practical as well as a theoretical man. Here are seventeen books devoted to the preliminary work: one, to tool design; three, to tool making; two, to foundry work; three, to pattern making; two, to forging; five, to machine-shop work, and one to machine-shop management. The qualities and properties of metals, the methods of working with them most efficiently, are explained with profuse illustrations. In the "Management" booklet, the development of American industry is briefly, but interestingly related; and modern office methods for the handling of an organization are detailed, with typical forms for the purpose. (To be continued.)

● **CORRESPONDENCE COURSE, School of Electricity. Published by L. L. Cooke Schools, Chicago, Illinois. (Continued.)**

Work sheets 14, 15 and 16 of this excellent course cover the subject of interior wiring, and the practical details of modern appliances and their installation with conduits, etc.

Sheet 17 introduces the subject of "induction," of which so much is heard in radio; and a mastery of which is necessary to the knowledge of electricity; 18 takes up indicating instruments; covering the theory and construction of meters; 19 brings us to the study of direct-current motors; and 20 to their operation and maintenance. Sheet 21 comes back to electrical values, analyzing problems involving them; and 22 goes on to the generator; 23 is given up to the important subject of armature winding; and 24 to generator operation. All these are exceedingly practical in their treatment. (To be continued.)

Jig-Saw from Old Auto Parts

(Continued from page 894)

16" long (Chevrolet steering rod), which has a key-way cut, 13" long. Fit bushing with a key and provide with a thumb-screw for locking, tilting or sliding. The table top is 1/2" oak, 15" square, split from the center to the front edge to allow table to be shifted for insertion of blades. The chucks are collars with hollow-head set screws, which fit over the push-and-lift rods. A dust blower is fastened on the original outlet of the air compressor, and is connected with an opening just in back of the head by windshield wiper hose. The pulley is a fan pulley from an old Maxwell, and an 1/8-horsepower motor drives the jig-saw.—B. N. Seibert.

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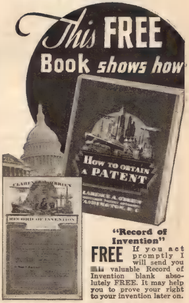
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How to Know the Planets

(Continued from page 891)

Saturn is almost stationary in the sky, and well placed for observation. On November 15, at 5:07 p.m., local time, at which time the Sun has set in practically any part of the United States, Saturn is due south. There is no other star as bright near him; and he should be recognized as soon as he appears in the twilight, a little west of south, and low in the sky. The bright star Altair will be a considerable distance above and to the west. (Fig. 4)

The planets Uranus, Neptune and Pluto are not visible to the naked eye; though the astronomer sitting up late would find Uranus well placed, and the early riser might take a glimpse at Neptune and even Pluto. The latter, however, is not a spectacle for an amateur's telescope, being very dim.

The annual movements of the planets

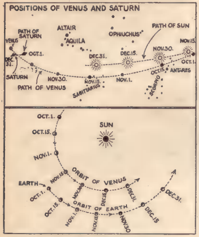

Fig. 4—Observe the corresponding dates, for positions.

The movements of the planets, as seen in the sky, are a combination of their own real motions, and that of the Earth. In order to have a fixed point from which to calculate, we take the stars as stationary, and the Sun as moving; although the apparent motion of the Sun is really due to that of the Earth, as the lower diagrams show. Similarly, the slight apparent motion of Saturn in the sky (upper left of Fig. 4) is almost entirely due to that of the Earth. In the case of Mercury, a very peculiar loop is caused, as shown in the dotted line. The orbit of Jupiter is shown in a box at A, on a very much smaller scale.

Aquila, with its brightest star Altair, Sagittarius, Ophiucus and Scorpio, with its brightest star Antares, are constellations or star groups of the southwestern sky. They are indicated on the small star maps. Antares resembles Mars closely in appearance.

On Nov. 18, Mercury passes between the Sun and the Earth. On Nov. 25, Venus is farthest east of the Sun. The Moon passes Jupiter Nov. 14, Mars Nov. 19, Venus Nov. 20, Saturn Nov. 22, and Jupiter again Dec. 12.

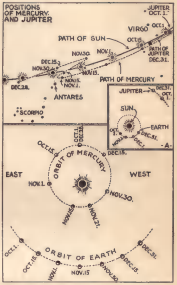

Fig. 5—Jupiter's orbit is drawn to small scale.

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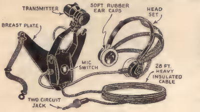

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in the sky are somewhat complicated—more so than these diagrams show; for the only loop they indicate is that of the quick-moving Mercury. But the planets go backward and forward among the stars in the sky; unlike the Sun and Moon, which travel apparently always from west to east, when their paths are marked down on a star map.

It is known, of course, to all, that the Sun and the Moon cross the sky from east to west; and so do the stars. But the stars cross the sky at a uniform rate, reappearing in the east every 23 hours 56 minutes; the Sun rises at different times throughout the year but, on an average, at intervals of 24 hours. The Moon is even more irregular in her times and places of rising; but reappears, on the average, every 24 hours and 59 minutes. The result is that the Sun and Moon appear to move backward among the stars.

The diagrams of the movements of the planets given here (Figs. 3, 4, 5) are in two divisions each. The lower part of each diagram shows the planet, the Earth, and the Sun in space (looking down upon them). The upper part of the diagram shows the movement of the planet, and of the Sun at the same time, in our sky. By picking out the planet's position for any day, and the Sun's position for the same day, the relation between the two can be seen.

For instance, take Mercury, which revolves around the Sun in 88 days (Fig. 5). On Oct. 1, Mercury appears east of the Sun, in the evening. On December 28, Mercury is west of the Sun, in the morning. But this is only because the Earth has also been moving around the Sun, in the same direction as Mercury. Mercury is actually **in the same place** as before. Comparison with the lower part of the diagram makes this plain. The peculiar motion of Mercury in the sky, according to the star map, is actually his motion around the Sun; and the motion of the Sun that we seem to see is really the motion of the Earth.

The same diagram shows, on a scale much reduced, the motion of Jupiter. It is very small; for Jupiter takes nearly twelve years to go round the heavens. But, because we are moving, we pass Jupiter every 399 days; and he seems to revolve round the earth in that time, though sometimes going forward, and sometimes backward—depending on our position in the Earth's orbit.

The planet Saturn moves so little, and is so far out, that it is not worth while to draw a plan of his orbit; and the same applies to Uranus, Neptune, and Pluto. The last is almost stationary.

Referring back to the planet Venus, which is the brightest ornament of the night sky—Venus, as Fig. 4 shows, is getting closer to the Earth very rapidly. She will be even nearer early next year, but will not then be as bright as on Dec. 31 of this year, when she will be about 37 million miles away. In fact, when Venus is nearest the Earth, we cannot see her—except, twice in a century, as a black spot on the face of the Sun. When Venus is nearest to us, her dark side is presented, and it is in the glare of the Sun. When the whole lighted face of Venus is turned toward us, Venus is farthest away, and the Sun is between us. The brightest appearance of Venus, as seen from the Earth, therefore, is when she looks like the Moon in the middle of her first quarter. A small telescope will show the crescent face of Venus. Mercury, for the same reason, exhibits "phases" of this kind.

We cannot, with the naked eye, see the phases of the planets, however, or their shapes; they are too small. The points sticking out in all directions are optical illusions.

Take a shiny dime; have a friend hold it up in the sunshine 300 feet away, with his thumb over three-quarters of the face of the coin. That's the size and brightness of Venus.

An eight-inch globe, bright and shiny, four-fifths of a mile away, is Jupiter. If Jupiter were as close as Venus, he would be 121 times as bright; and, even in the daytime, the shape of his face could be seen; for his breadth would be apparently a third that of the Moon. Even the Earth, if there were people on Venus to see our own planet, would appear three times as bright as Venus does to us, and could be seen with the Moon circling around her.

As said before, Mars and the fixed star Antares look very much alike, in color and brightness. But the difference disappears in a telescope; in which Mars develops a disc—not quite a full circle, as a rule—while Antares remains a mere point of light. It is estimated that the diameter of Antares is 70,000 times that of Mars; but Antares is more than three million times farther away than Mars at his farthest.

The illustration heading this article (Fig. 1) shows the comparative amounts of light which the planets reflect from the Sun, at their average distances. These are affected by their sizes, their distances, and the reflecting power **(albedo)** of their surfaces. Seen from the distance of a fixed star, therefore, their brightnesses would be in the order indicated—first Jupiter, then Venus, then Saturn, and then the Earth. But, from the nearest star, even Jupiter, nearly five hundred million miles from the Sun, would be lost in his glare.

Nevertheless, astronomers on a planet of **Alpha Centauri** (if a double star can have a planet) might conceivably detect the existence of Jupiter, if they were able to observe the Sun's motions for a sufficiently long time; just as the companion stars of Sirius and Procyon were believed to exist, before they were seen. The center of balance between the Sun and Jupiter lies slightly outside the Sun's surface; and therefore, in the great orbit of the Sun (which we cannot see, for we are practically in it) there must be motions, back and forth, of our great luminary, as Jupiter, Saturn and the other planets swing round him. In other words, as seen from a nearby star, there would be a slight waviness in the motion of the Sun as he apparently travels through space, at a rate of several miles a second. The observed amount of his wobbling would be small—just at the limit of our most delicate instruments.

Returning to our own Earth, although Jupiter gives more light than Venus, and we cannot see more than a small part of Venus when the light of the latter planet seems brightest to us, Venus seems to us brighter than Jupiter, because more than ten times as near. The brilliant Saturn is dull to us; and it is said that an inhabitant of Saturn could not see our Earth, for the glare of the Sun.

Here are some comparisons of sizes and distances in the solar system. On the comparative scale of sizes in the upper half of Fig. 1, the diameter of the Sun would be 14 inches. Mercury would be from 38 to 57 feet away, depending

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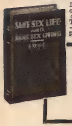

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on his position in his very eccentric orbit; Venus 88 feet; the Earth 123 feet; Mars 170 to 200 feet; Jupiter 660 to 720 feet; Saturn from 1020 to 1240; Uranus 2,000 to 2,500 feet; Neptune 3,700 feet; Pluto a mile, from the Sun. The Moon would be about four inches from the Earth; the nearest fixed star (Alpha Centauri) about 3,100 miles from the Sun, or at a distance equal to that across the Atlantic Ocean.

Experiments with Sulphur

(Continued from page 888)

by means of a strip of filter paper moistened with a solution of lead nitrate in water. Whenever hydrogen sulphide is present, the moist paper will darken, indicating the formation of lead sulphide. This test paper can be prepared, dried and cut into thin strips. Keep it in a tightly-corked bottle for future use, and label it "Test paper for H_2S."

"Milk of sulphur" is made by boiling about 2 grams of powdered sulphur with lime-water in a test tube for a few minutes; this particular solution contains **calcium polysulphide.** Now, add a few drops of hydrochloric acid, and a very coarse colloidal solution of milk of sulphur is obtained.

The lime-and-sulphur mixture gives us an insecticide and a fungicide. Strong lime-sulphur spray is used on fruit trees in the winter to kill scale insects; while weaker solutions are used during the growing season on leaves and fruit as a killer of fungi.

Slake a quarter pound of burnt lime (calcium oxide) with a quart of water. Then add half a pound of powdered sulphur, and boil the mixture for one hour. If desired, larger quantities may be used, employing the same proportions. When the solution is cool, strain out the lumps and bottle it. This is the **stock solution** of "lime-sulphur spray"; label it as such. For use during the winter, for killing scale insects, dilute each ounce of stock solution with 9 ounces of water. In the summer, when the leaves are on the trees, dilute each ounce of stock solution with 40 ounces of water.

Microscopy for the Beginner

(Continued from page 885)

for certain animals and plants are restricted to particular localities. If this is done, more of the material can be obtained at any future time. This solution is not so successful for preserving, and fixing the flagellates and other ciliated animals, like the wheel animalcules. Here the well-known Fleming's solution steps in. This uses 2½ grams of chromic acid, one gram of osmic acid (the yellow crystals) and 1 c.c. of acetic acid in one liter of water. This is a dangerous and a very expensive mixture and is mentioned only because it is a standard and much-used fluid. The danger is due to the osmic acid (which is sold in quantities as small as half a gram and costs about three dollars) which attacks the eyes and the breathing organs by the fumes it gives off. The mixture is ideal for fixing nucleus and plasma structures; it also stretches out cilia and will blacken fatty tissues.

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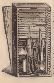

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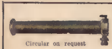

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Potassium bichromate, 3 grams in 100 c.c. of water, to which is added a solution of 5 c.c. of glacial acetic acid in 100 c.c. of water, is also used for a fixing solution. It is good for fixing nuclei.

These last two fixing fluids should not be used longer than 24 hours. Then the subjects are to be thoroughly washed with water and brought into 15% alcohol; where the tissue is left until further treatment or study is desired. When the material used is exceptionally soft, as some of the algae, then it is transferred into 10% alcohol. When it is placed in a bottle or vial, be sure to label it.

Where permanent slides with canada balsam mounting are desired, further dehydration is necessary. For glycerin mounting, glycerin is substituted for the alcohol. Details of this method will be published in a later installment.

Amateur Telescope Making

(Continued from page 887)

and washers which can be drilled and cut, from sheet brass or zinc, with tin shears and an ordinary brace and bit. A hack saw, a file, and a soldering kit are about all the other tools needed. While it is shown in use holding the optical parts of a Huyghenian ocular it is just as suitable for the Ramsden.

The **Huyghenian** is a negative eyepiece. The two lenses are of different focal lengths, and placed with their curved surfaces turned away from the eye. A diaphragm or stop is placed between them, in the focal plane of the eye lens. Before the field lens is inserted the stop is pushed, until it is in focus when viewed through the eye lens. This stop cuts off stray light and limits the field. In Fig. 9, the lenses are held between washers which are separated by lengths of smaller tube. All are held together in the eyepiece by the retainer ring which is pinned, soldered or held in place by friction.

Lenses may be made as described above, or purchased ready made. Brass tubing can be purchased in convenient sizes. If your cells are to be threaded to the tube, get 1¼" outside diameter tubing with 1/16" wall; if assembled as in Fig. 9, get both 1¼" and 1 3/16" tubing with 1/32" walls. A 1 5/16" tube of this same gauge is just right for the eyepiece tube of the telescope, as the 1¼" eyepiece fits nicely into it.

The table gives specifications for both kinds of eyepiece. Decide what power (f) you want and then find the various focal lengths, separations, etc. from the formulas given in Fig. 10.

Fig. 12 is a **terrestrial** eyepiece; it is suitable for a small refractor used to look at terrestrial or earthly objects, since it shows objects right-side up, while astronomical oculars show objects inverted. The Newtonian reflecting telescope, however, shows objects erect, even with an astronomical ocular, if the observer stands with his back to the scenery, puts the telescope horizontal with eyepiece on top, and observes in this position. Actually, the experienced observer becomes so used to seeing things upside down that his brain rights them unconsciously.

It is customary, therefore, in reproducing photographs of celestial objects, to show them as the telescope reveals them—inverted. The familiar pictures of the Moon, Mars, Jupiter, Saturn, are of this kind.

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100 Million Years From Now?

(Continued from page 880)

thousand years to complete one of its swings. The illustration on the left of page 880 below the map, shows the direction of the Earth's axis at present; at the right, we see its direction after a turn and a half has been made. At that time, the stars we see now in summer will appear in winter; and our winter stars—brilliant Orion and Sirius, the Dog Star—will blaze in summer nights.

It may seem that a swinging of the earth's axis—which we see as a swinging round of the stars—every twenty-five thousand years is an infrequent occurrence. But, if the world is 2,500,000,000 years old, it has wobbled round like this a hundred thousand times, at least. No one, not even an astronomer, can figure out what stars were around the solar system when it was born; and, a hundred million years from now, not one star we now see in our sky will be visible to a human eye. Perhaps a very bright one (like Rigel in Orion) might be visible through an enormous telescope. The movements of our Sun and the other stars will have brought us into another region, thousand of light-years away from our present position in our Galaxy.

But, if nothing has happened to the Sun, our Earth may still be the abode of life. (Possibly insect life, only, not human.) If anything does happen to the Sun, which is a cooling star, it is not probable that life such as we know will continue on the Earth; though there may be possibilities on other planets.

Allowing that Old Sol continues on the even tenor of his way, and that the Earth continues to wobble around in its orbit, at very much its present distance from the Sun, what will conditions on the Earth be like?

There may be less water on the face of the Earth; a certain amount will be absorbed into the crust. One scientist, a few days ago, predicted that the proportion of "heavy" water (containing hydrogen twice [illegible] heavy as that best known to us) will so increase, by the disappearance of the lighter-hydrogen, that life will be impossible. But, in so very gradual a change, it is quite probable that the evolution of the human organism will fit it to changing conditions. And, for drinking purposes, sufficient normal water might be recovered by disintegrating the rocks of the Earth, which have absorbed it in great quantities.

The day will be longer; perhaps several hours longer. Some look forward to a time when the tidal action of the Moon will brake down the Earth's motion, while increasing its own speed as it descends. One theory is that the Moon and Earth will revolve, locked together; the Moon completing its circuit of the Earth in one lengthened day, and approaching it. The Moon, at least, will not fall to the Earth in one piece; it will burst before that time, and become a ring, like those of Saturn. But even a hundred million years looks like a short time to allow for this.

It is believed that the continents are adrift on the soft, partially fluid mass of the interior of the Earth. They move, like ice fields in the Arctic, though more slowly, but more surely. In the early history of the Earth, they certainly could travel faster than they do now. One theory is illustrated here; that all of them were one, around the South Pole; and that the great original or primordial continent broke apart. Its sections gradually drifted apart, and then came together in a different arrangement. We know that the animal life of South America, Africa and Southern Asia was once so similar that geologists speak of them as having formed one original continent of "Gondwanaland." We know also that Asia and North America must have been connected by land. The hypothesis mentioned above gives an explanation for this, though there are many difficulties to be cleaned up. Then, too, radio and astronomical observations often indicate a few feet of difference in the distances between two given continents, at two readings. If the continents are moving, even at the rate of a few feet a century, the map of the world has not yet reached its final form.

If, as some indications suggest, the continents are recoiling slightly from their last collision, South America will swing away from North America, which will interlock again more tightly with Asia; while the Atlantic Ocean will widen, and Africa pivot back on Asia. New lands and new seas will appear—very gradually. Shores will rise and fall; islands will be worn away; mountain chains will be forced up from below, where there is stress, and then washed down into the sea again by rains.

There probably won't be a thing, that exists today, then recognizable on the face of the Earth. But the Earth will still go on—and on.

Heater Burns Crankcase Oil

(Continued from page 892)

is mounted on an angle-iron frame, which also supports the nozzle. The fuel stream is directed against [illegible] firebrick and, as soon as this is hot, the combustion is perfect.

This heater warms up [illegible] very large garage in a very short time and consumes less than four gallons of waste oil per day. The original was in use all last winter and is surprisingly efficient. —Hi Sibley.

Odd Views

(Continued from page 883)

a trick photo—the chimneys are actually twisted. The scene is in the old city of Orvieto, Italy. The chimney builder, it is explained, made his stacks in spirals to increase draft and blow smoke rings. (That's the photographer's story, and he sticks to it.)

Making Ice from Warm Water

■ BY a method not unlike that which he used to obtain power from tropical sea water, Dr. Georges Claude, the neon-tube inventor, now proposes to produce ice; that is, by utilizing the differences in temperature between the bottom of the sea and the surface. (See "Our Future Motive Power," by Nikola Tesla, in our November, 1931, issue.) He is fitting up a French ship of 10,000 tons, the "Tunisie," for the purpose. Thus, he suggests, with cheap ice, life can be made more comfortable and healthy in the tropics.

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" II. Nude Adult M[illegible]
" III. Nervous System of Female
" IV. Skeletal System
" V. Muscular System (Posterior)
" VI. Muscular System (Anterior)
" VII. Vascular System
" VIII Respiratory System
" IX. Digestive System
" X. Male Genital Organ in Detail
" XI. Female Genital Organ in Detail
" XII. Cross-Section of Pregnant Female Body with Child.

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The Oracle

(Continued from page 904)

magnet when the ends of the wire are connected to the terminals of a battery.

The amount of current consumed depends on the resistance of the wire, determined by its diameter and the number of turns. For a small magnet, approximately 1½" long, with a core ¼" in diameter, No. 28 wire wound to an overall diameter of 1", will make a suitable electromagnet for 6-volt operation. If carbon steel is used in the making of the core, all of the magnetism will not disappear as soon as the current is switched off; but if soft iron wire or cast iron is used for the core there will be no magnetism when the current is turned off.

The pull varies directly with the number of ampere turns; the greater the amperage flowing and the greater the number of turns on a core of suitable size, the greater the pull.

The "eye magnets," used for extracting particles of iron and steel from the eyeball and its vicinity, are extremely powerful and concentrated in their action; one pole of the magnet being brought to a point for this purpose. A typical one, operated on about 6 volts, direct current, is wound over [illegible] core which is built up of lengths of soft iron wire, 6" long and 1¾" in diameter, and covered with a layer of insulation. This is then wound to an external diameter of about 4", with 14 to 18 gauge double-cotton-covered wire. It draws a very heavy current, but is used for only an instant at a time. (Fig. Q 129.)

(130) Crystal Radio Sets

Can a loud-speaker be used with a crystal radio set? How can it be connected up?

MRS. J. F. NOFSINGER,
Navarre, Ohio.

A crystal set will not work a loud-speaker, because it has no power of its own. Within a reasonable radius of a broadcast station, it will operate [illegible] pair of sensitive phones; but power enormously greater is required for a loud-speaker. Similarly, a crystal set requires a long aerial, because it gets only the electricity which actually surges back and forth in the aerial, to work its phones; while a tube set may have an "amplification factor," over all, of several millions, and a foot or two of wire will pick up enough signal to overload the speaker. Crystal sets are therefore reliable only for local reception; and, because they have no power to spare, they cannot be made highly selective. It is possible to use tube amplification before and after a crystal; before it, to amplify the radio signal; and after the crystal, to increase the feeble sound impulses up to loud-speaker strength. But the crystal adds nothing to the receiver's volume; although, when compared with early tube circuits and their distortion, it has been praised as giving more correct tones.

(131) Hydrogen-Oxygen Explosion

At what percentages is hydrogen mixed with oxygen the most powerful explosive? How does it compare with other explosives in regard to power?

MELVIN SWICK,
St. Louis, Missouri.

Eight parts by weight of oxygen are required to burn one pound of hydrogen. The action, however, is most effective when there is a little additional oxygen; since otherwise, under the heat created, there is a tendency to reverse chemical reactions.

For several reasons, a mixture of hydrogen and oxygen is not very convenient to handle as an explosive; since, except in the liquid form, it cannot be applied very directly to the object to be blasted. It contains more energy, pound for pound, than almost any other fuel combination; but it is much easier, for instance, to soak charcoal in liquid oxygen than to mix hydrogen and oxygen, which evaporate at different temperatures, and require special containers.

The violence of the explosion is one thing, and the energy liberated another. Fulminate of mercury and chloride of nitrogen detonate with great suddenness, though their stored energy, weight for weight, is far less than that of gunpowder. They will shatter objects which gunpowder will merely hurl away in [illegible] single piece. Nitroglycerine exceeds gunpowder several times in both force and rapidity of explosion when detonated. Other substances, such as T.N.T. [Trinitrotoluene — $CH_3\text{-}C_6H_2\text{-}(NO_2)_3$] are safer and more certain in action than nitroglycerine and, though their energy, pound for pound, may be less than that of oxygen-hydrogen, it is practicable to ship them and keep them in packages, shells, etc.; which it is impossible to do with the latter.

(133) Radio Prescriptions

Recently I made some repairs on my radio. When I turn the volume control to play thinner, I get a lot of whistles and shrieks. I would like you to print in the next issue how to eliminate these noises.

LOUIS VIECK,
New Castle, Pa.

This is like writing to a doctor: "I have a pain. What shall I take for it?" It is impossible to answer a question like this without a diagram of the connections of the receiver, showing the changes on it, and at least a set of meter readings on the tubes of the set. Even the Service Editor of a magazine like **Radio-Craft**, devoted to set problems, can't prescribe for a set, sight unseen.

However, it may be remarked that a tone control is intended to cut out tones, not to put them in. If the whistles are not apparent when the control is turned for bass reproduction, the control is working. The set itself is making the squeals, which come out only when the tone control ceases to suppress them; and there is quite probably unwanted regeneration somewhere in the set. A suitable set tester will show up the radio's tummy ache very quickly.

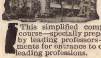
(132) Photography on Silk

What formula may be used for sensitizing cloth [illegible] that one may print on it?

HARRY KLEIN,
Brooklyn, N. Y.

A formula for sensitizing silk is to prepare it by thorough washing, to remove any soluble substances with which it may be "loaded"; then soak it in a solution to give it body, made as follows:

To 100 parts of water, add 4 parts (by weight) of starch which is dissolved



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under gentle warmth then 4 parts of salt (sodium chloride) and 15 of acetic acid. Then add another hundred parts of distilled water, in which 4 parts of tannin have been thoroughly dissolved, and mix.

After the silk has soaked for three minutes in this liquid it is stretched out carefully to dry. Then it is to be floated for a minute on the surface of a 12% solution of silver nitrate (to which a trace of nitric acid has been added—⅛%) in a shallow tray. The cloth is hung up till almost dry; then thoroughly dried while stretched on a flat surface; all this in a dark room, since the silver nitrate is the sensitizer.

Prints are made upon it as on paper, and it is washed and toned in a similar manner.

(134) Plating—Airplanes

(1) Do chromium plating solutions, using no electricity, apply a coat of metal by electrochemical action, just like in a bath?

(2) Could an airplane be propelled by the principle of suction, to suck it forward?

CHARLES RUBEN,
Duluth, Minnesota.

A metal will be dissolved by a salt of any other metal **below** it in what is called the E.M.F. (electromotive force) series of metals. That is, if we put a solution of a copper salt on a piece of iron, a thin layer of iron is dissolved, and the copper is deposited instead on the face of the iron. This is an electrical action, as well as chemical; the electricity is liberated, just as in a copper-and-zinc wet battery (the old "crowfoot" cell used in telegraphy) where the zinc is dissolved, thereby creating the flow of current. Thus, it is easy to wash silver on copper, or copper on tin, or tin on iron. Unfortunately, chromium is well toward the top of the E.M.F. series, with only manganese, zinc and aluminum above it.

Washes of metal thus electro-chemically obtained are very thin, and easily worn off, however; while those applied with a battery may be built up to any desired thickness.

(2) Most airplanes are propelled by suction; the propellers draw them forward, and the suction above their wings keeps them from falling. It is true that some propellers are of what is called the "pusher" type; but all propellers are alike in principle. They create a vacuum ahead, which sucks them forward; while they build up an air pressure behind, which pushes.

(135) Oxidizing Processes

How can copper sheet be coated with an oxide? I have made several inquiries among my science teachers, and they suggest heating it, but the oxide coat won't stick.

A. KENIGY,
Kingston, Pa.

If the copper is pure, after thoroughly cleaning it, cover it with dilute nitric acid, thinly, and heat it gently in a flame. The fumes must be carried away in a flue, as they are poisonous. The copper nitrate decomposes at a moderate temperature.

The Science Forum

(Continued from page 902)

that the salt, when in solution, ionizes and the dissociated chlorine atoms unite with the aluminum to form aluminum chloride in a colloidal state. This is hard to understand, or even explain, to a person who has had no knowledge of chemistry.

The possibilities of some suitable coating or spray, in the metallurgical field, are rare, as other metals as light or lighter than aluminum have the same properties or are very expensive, making the project commercially impossible.

I might add that water containing one-tenth of one per cent of salt will have a detrimental effect on aluminum; what will ocean water, which has three per cent of salt, have on such a vessel? It was for this very reason that Piccard's stratosphere gondola, which is "aluminum composition," started at Chicago, for fear it would land in the ocean and be destroyed!

IRVINE RUSSELL,
Grand Rapids, Mich.

(The difficulty of constructing aluminum vessels is not so great as you might think. Pure aluminum is not attacked rapidly by salt water, and there are [illegible] number of ways to overcome the trouble with aluminum alloys, such as Lynite and others; there are certain paints which can be used, and [illegible] number of other trade artifices. Even iron, which normally is not attacked by salt water, requires frequent painting; and you will notice that every ship is completely repainted every [illegible] often for this reason. During the next few years, this technical difficulty will be solved, if it really exists, as have been many other similar difficulties.—Editor.)

Arc Welding

Having read his articles on arc and spot welders, I would like to know what position Mr. W. C. Cheney holds as an electrical worker, and what company he works for. He must be more than the ordinary experimenter.

I would also like to know if your laboratory tests have proved that the welder will do what Mr. Cheney says it will. Having little money, I do not want to invest in something that I am not sure of giving good results.

Your articles on electric equipment are certainly what we mechanics, and small shopworkers like; keep up the good work.

A little sketch of the author's life would be very good in each article.

FRANK MILES,
Glenville, W. Va.

(We have had a tremendous response to Mr. Cheney's welding articles, and there has been [illegible] continuous demand from our readers for home-made welders.

Mr. Cheney is a professional, and lives in the state of Washington. He is more than an experimenter, and has built and sold [illegible] great deal of commercial welding apparatus.—Editor.)

Chemistry and Astronomy

I recently began reading this magazine, but I have been buying up the back numbers, and I soon hope to have [illegible] complete file of it. I think it about time, though, that you began keeping some of your promises in regard to chemistry. It has already been some months since you began saying things about increasing your chemical department; instead, you've decreased it. There also have been quite a few readers asking for some astronomy and, as I am also interested in astronomy, I add my vote to those already given.

It is generally accepted by most astronomers that the moon has at one time possessed an atmosphere which it lost because of its lack of gravitation. I think, though, that the moon would have retained some of its atmosphere in proportion to its size. I would like to know if this supposed atmosphere would support life. I would also like to know, whether, if [redacted] large meteor collided with the moon, could we see the collision on earth?

I find the editorials of great interest, and up to now haven't found any more to my liking. Let's have some more by other editors. I think that the publishing of a S.&M. quarterly edition would be just fine. It's a great idea, and here's hoping that the idea will soon become a reality.

MEYER CHRISTAL,
Brooklyn, N. Y.

(We believe you will find the present issue satisfactory to your needs, so far as chemistry and astronomy is concerned.

When we speak of the moon as being without an atmosphere, we mean that [redacted] compared to our own earth, it has practically none. There is, however, little doubt that there is some little air left in the interior of the moon; and indeed, Prof. Pickering believes that he has detected moving vapor on the bottom of some of the moon craters. It may be, however, of unbreathable gases, like chlorine, krypton, xenon.

So far, no astronomer has seen the direct impact of [redacted] meteor colliding with the moon; but there is no doubt that, if [redacted] very large meteorite should fall [redacted] the moon, the effect could be seen on earth. It would have to be a pretty large body, however.

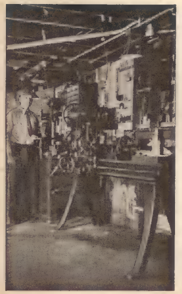
When economic conditions get better, it is possible that we may bring out a quarterly for EVERYDAY SCIENCE AND MECHANICS.—*Editor.)*

An Old Hand

Just a few words to the most interesting magazine of all (and I read several of them).

I am one of the readers of the former "Electrical Experimenter" and "Science and Invention."

You sure have come back with just what we want. I suggest you make it larger, even if you have to charge us a little more for it. All articles are very interesting, especially those on lathe work, and construction, such as the one on telescope making; also those on shop work are very good—give us a lot more of them.



One side of Mr. Pantel's home workshop; other electrical equipment is in the corner behind him.

Leave E.S.&M. as it is, only again I say: "Make it larger." (About four times, and then it wouldn't last me through the month.) Otherwise it is O.K.

I am sending you pictures of my shop; it is [redacted] basement location. I have a South Bend lathe, 13 in. by 7 ft., with milling attachment and electric tool post grinder; sensitive drill; ½-h.p. electric grinder; air compressor; three sets of drills, four sets taps and dies; many small machinist's tools such as micrometers, dial indicator, reamers, milling cutters, etc. I have motorized my shop and use no line shaft. Now, before I forget it, here is a check for which please extend my subscription for one year. I do not want to miss a single copy.

FRANK L. PANTEL,
Muscatine, Iowa.

(We are glad to print your photographs, to show other readers what can be done. Here is a very compact workshop, which can be emulated by many readers. If you have any good photographs of your shop, be sure to send them to us. We will be glad to publish them from time to time.—Editor.)

100% Chemistry

Your magazine has been of great value to me. I am interested in science, chiefly chemistry and physics. I have secured much valuable information through your splendid articles in chemistry. I entirely agree with Floyd E. Cox. Why not print a magazine entirely for amateur chemists? I am sure it would be in great demand.

On the whole, I think your magazine is the best of its kind in both the U.S.A. and Canada.

ROBERT B. LANE,
Fonthill, Ont., Canada.

(We refer you to our answer in a preceding inquiry. Amateur chemical magazines have been considered by a number of publishers, but they have never been able to get anywhere because, at least until the present, the chemical experimenters have not been sufficient to warrant the publishing of [redacted] independent magazine.—Editor.)

A Chemical Blowout

The news that E.S.&M. is soon to be increased in size sounded very pleasantly in my ears. My only hope is that we chemisters and electrical experimenters will no longer be so sadly neglected. Your policy as regards extreme simplicity in chemical articles is very probably in error. You are not even consistent in this stand throughout the magazine. In some of the auto-generator articles such things as "growlers," lathes, grinders and whatnot, are specified; this material is to be found only in the laboratories of advanced experimenters and in commercial auto and machine shops. As you probably realize, a great many of your readers are boys of high-school age who are primarily interested in chemistry and electricity simply because the supplies needed in these sciences, even though fairly complicated, cost little and are fairly easy to get.

Why have extreme simplicity in chemical experiments and great complexity in electrical construction? Whoever heard of one of these boys whacking out fifteen or twenty bucks at a time for one piece of apparatus? "If such there be, go mark him well; his dear papa is rich as hell." But us poor lads that work in dusty cellars, or in low-ceilinged attics, where every time we stand up our heads go through the roof, haven't the dough, and even if we

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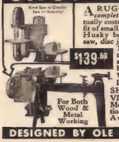
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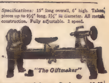

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did, good old hard-working Mom and Pop wouldn't hear of "throwing out that much hard-earned money for your experimental junk."

Thomas Reed, that wonderful old-timer, knew this fact, as did that fun-loving son-of-a-gun, Esten Moen. I wonder what became of these boys, real experimenters, who knew that ideas and brains to construct much from little create the experimenter, and not [illegible] wonderful array of machine tools. "I know you've got a wonderful shop, but what d'ye do?"

There's only one thing to do about it, Mr. Editor, and that is to give us a few more he-man ideas and start up that only reliable source of supply ever formed for the benefit of urban or rural experimenters, the Electro Importing Company. Will you do it?

WILLIAM S. SYKORA,
Long Island City, N. Y.

(There are two classes in almost any human endeavor; one being strictly amateurs, the other professionals or semi-professionals. The latter usually snort at the amateurs, for whom they have no consideration at all. This might be called snobbishness and exists in chemistry as well [illegible] in radio, stamp collecting, and what have you. The purpose of the magazine is to satisfy all classes. For that reason, we have sometimes the simplest possible articles in chemistry, and at other times more advanced ones. Whenever we do this, we hear from both classes: to [illegible] class it is above (or below) their heads; to the other class it is pleasing. You see, we must take care of all of our readers. It is [illegible] mistake to think that most of our readers are boys of high-school age; the reverse is the fact. We have thousands of executives, engineers, and others who read our magazine regularly. We may say that one article, on arc welding, has produced more letters, largely from men in business, than all our chemistry readers combined have sent in since the magazine began.

We are glad you have mentioned Esten Moen, and you will find him reappearing in the present issue; we will see what we can do with Thomas Reed. There are a number of small chemical supply houses; but the business has never warranted a great investment of capital because there do not seem to be enough chemisters to make it worth while, at least, up to now.—Editor.)

An "Element"-ary Suggestion

Name of Element: Atomic Weight: Valence.

Principal ores containing said element.

Locality where found.

Process of recovery of element from its various ores.

Physical properties.

Chemical properties.

Commercial uses of element.

Above is my suggested outline for a series of informative articles about the ninety-two (92) elements which compose our earth. These articles would occupy the space now occupied by those detachable postcards in the back portion of "Everyday Science and Mechanics." If this is impossible to do (placing the articles in the rear as I suggested) please put them somewhere so that, if you cut the articles from the magazine, you won't mutilate any articles printed on the rear side. Please give this suggestion your deepest consideration; for a series of articles like this would be met with hearty approval by "your chemisters."

FRED HIESTAND,
St. Louis, Mo.

(Thank you for your suggestion, which has been received with considerable satisfaction, for the reason that we have had such articles as you suggest in preparation for [illegible] time. You will find them in early issues.—Editor.)

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To bring this useful service manual right up-to-date. Mr. L. K. Wright, the editor of the OFFICIAL REFRIGERATION SERVICE MANUAL, has added [illegible] wealth of material on new electric refrigerators, and older models [illegible] well. As usual, every refrigerator has been accurately described from the viewpoint of servicing—diagrams to illustrate the essential parts, so simplified that repairs can easily be made. The addition of these new pages will not increase the cost of the book to those who order their copy now.

Here Are Some of The Important Chapters:

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Fundamentals of Refrigeration
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Glassblowing

Magazine steadily improving, especially old auto parts and windmills.

W. C. Cheney's articles are just what I wanted. Get some more, **many** more.

If possible I should like to see a **good** article, or series of them, on glassblowing, copiously illustrated and giving instructions on making tools and the different types of glass to be used.

A. J. DEMPSEY,
Chicago, Ill.

(We are pleased to see that you are looking for an article on glassblowing and glassworking in general. We have such an article scheduled for an early issue, and we ask you to look for it there.—Editor.)

"The Junk Heap Searcher"

I am writing to commend, and offer a few suggestions to you on your magazine.

The first thing I would like to mention is the annoying way in which it is printed. You start reading an article, get half-way through and then find that you have to turn right to the other end of the book to conclude the item. I'm sure you could arrange it so that you merely turn over one page.

I am sorry to see that you have started that auto-part stuff again; I can't understand why you don't rename the magazine, "The Wood Worker and Junk Heap Searcher;" certainly not "Science or Mechanics."

The May number was by far the worst issue I have ever read; I could not find one article of interest, let alone science in it. I have just received the June number and, after reading all the appeals for chemistry and electrical experiments, I can't understand why you don't do something about it. You certainly ought to study the majority, and I'm positive my side's stronger than the auto stuff.

Now for a little praising, the article on the "Tesla and Oudin Coil" was great; let's have some more, and the Experimenter's issue was how I'd like to always have the mag: just like the old **Science & Invention.** That article on "The Spectrum" was also worth waiting for.

The astronomy and items of general interest, etc., are also good.

Lastly, you're always asking for items, suggestions, and what not; so here's a few things I would like to see appear:

I have just acquired a spectroscope, an article which I expect many readers also possess. Of course, I realized from the start that the first you must do is to obtain a chart of all the different spectra. How the heck can you test for indium, gallium or neon, etc., if you do not know what lines to look for? The only charts you can buy are of the common elements (such as sodium and potassium) and oh, the price of them—far above my pocket.

Now what I suggest is to publish in the mag, month by month, a complete spectrum of every element. Such a chart could be cut out and framed, and would be an article of real value on the walls of the lab.

I should very much like to see an article on the construction and experimenting with photoelectric cells; how to make a selenium cell, wire it up, etc.

How about sparing a little room for X-ray apparatus and photos? The construction of vacuum tubes, and an item for obtaining argon, helium, and neon, etc., to fill them with, would be more than welcome.

Well, I guess that's the lot. Wishing you and the mag, every success,

HENRY WILDEY,
London, England.

P.S. Do you pay anything for articles sent in and published; if so, may English readers contribute?

(Thanks for the wholesome brickbat all the way from London. We have in the past published some articles on experiments with photoelectric cells. We have some articles along this line scheduled for future issues. Watch for them.

It is not possible for the experimenter to construct a worthwhile X-ray tube; and, in general, the construction of vacuum tubes of any kind is a most difficult task, since you must have a specially-equipped laboratory and workshop before you can undertake such work.

All articles which appear in this magazine by contributors will be paid for. There is no restriction on nationality.—Editor.)

Microscopy

I have been a constant reader of your magazine, and think it's one of the best on the market. I see that you are enlarging it and I would like to have a department on the microscope photography; and articles on how to sharpen, repair, and put to use old tools in the shop and lab.

HARRY ROTHSTEIN,
Brooklyn, N. Y.

(You will find in our November issue, a good article in microscopes, and we have several of these scheduled for the coming issues. We hope you will like them.—Editor.)

Rocket Experiments

The article entitled, "Plan Fifty-Mile Climb," on page 745 of the October issue, was undoubtedly based on a report that was circulated several months ago by an enthusiastic newspaper reporter, and which we have been since trying to stifle.

The Cleveland Rocket Society is not planning a space-ship as yet, but must be contented with patient experimentation on small liquid-fuel rockets, capable of ascending to the stratosphere with instruments alone.

We would be greatly indebted to you if you could make a correction regarding the space-ship report; as we are endeavoring to place the science of rocketry before the public in a clear and conservative way which, as you understand, cannot be accomplished by spectacular reports.

CLEVELAND ROCKET SOCIETY,
Cleveland, Ohio.

By Edward L. Hanna, Secretary.

(The article, on the Science News page, was based on press reports; but it is evident that the Cleveland Rocket Society has its feet on the ground in its experiments. No one appreciates better than the rocket experimenter how much painstaking and costly detail work is to be done before even the stratosphere rocket will be a success.—Editor.)

Aluminum Ships

With reference to Mr. Irvine Russell's letter, in the Science Forum (page 902), perhaps the best way to answer it is to point out a few rather well-known uses of aluminum which will tend to indicate that his statement of the effect of salt water on aluminum is somewhat exaggerated.

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31x5.25-21	3.25	1.15	33x5	3.75	1.45
28x5.50-18	3.35	1.15	35x5	3.95	1.55
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EVERYDAY SCIENCE AND MECHANICS
[redacted] Park Place New York, N. Y.

SAVE MONEY

The best illustration is, without doubt, the use of aluminum in seaplane hulls and structures. The famous Sikorsky Amphibians, as well as a large number of naval flying boats, have a great deal of aluminum in them. Various motor boats have also been made from aluminum and used successfully in salt water. These applications are, of course, not so well known and will, perhaps, prove nothing.

A great deal of aluminum has been used on board our naval vessels. Some of it, such as porthole windows, has been on the outside of the vessel and a great deal more, such as furniture, has been inside, where it is exposed only to the salt atmosphere and not the salt water itself.

You will note that we have not made the statement that salt water does not corrode aluminum. When our alloys are to be exposed to salt-water conditions, we are very careful to see that adequate protection is provided. In this connection, remember that steel and other commonly used material of construction require similar protection from salt water.

The extreme care and conservatism which we exercise in such applications as these may seem to indicate that our alloys are less resistant to corrosion than they actually are. For instance, although seaplane hulls are regularly made from aluminum alloys, we would not be at all eager to have someone build the hull of a large passenger liner from our alloys. We would feel that such a move would involve an experiment on a much larger scale than is justified.

Professor Piccard's gondola was made from Dow metal, which is a **magnesium** and not an aluminum base alloy. Also, with the World's Fair as an attraction to Chicago, it seems unnecessary to seek any further motive for starting the flight from there.

ALUMINUM COMPANY OF
AMERICA,
New Kensington, Penna.
By A. B. Wilber.

Synchronous Motor

(Continued from page 899)

removed. (To magnetize the piece of spring, stroke one end on one pole of a permanent magnet, such as the horseshoe type found in a magneto or a telephone; then reverse the permanent magnet, and stroke the other end of the spring with the other pole.) The length of the pinion used to hold the piece of spring should be taken into consideration when bending the frame, so that the frame when attached to the wooden block will be the right height. The wheel when running should just clear the end of the iron core in the coil. It is a good idea to place the coil on the frame, so that the core when magnetized will tend to lift up on the wheel. This arrangement will reduce the friction on the lower bearing. To place the wheel, drill a ¼" hole in the end of the frame at the correct point; then solder, over the hole, the section of the clock frame that contains the adjustable screw that held the balance wheel in the clock. The lower bearing is another section of the clock frame containing a hole to accommodate the lower end of the steel pinion; this piece is held in place by two small screws. Place a small piece of glass under the bearing to reduce the end friction on the wheel shaft. Two binding posts are placed at the end of the wooden block, to attach the wires from the coil to the source of current.

The coil is energized from a stepdown transformer having an output of only several volts. The lowest voltage of [redacted] toy-train or bell-ringing transformer will supply the required alternating current.

To start the motor, connect to the current and snap the end of the spring with one finger, so that it will turn at a high rate of speed. Adjust the set screw on the top and lubricate the bearings with sewing machine oil. After a little practice the motor can be started at different speeds.

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A Symbol

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Customs change, but the Christmas spirit is ageless. Today millions express it by the purchase of Christ[redacted] Seals—the penny stickers that fight tuberculosis—still the greatest public health problem. Your pennies will help.

BUY CHRISTMAS SEALS

(Continued from page 872)

More Speed for Less Power

which are now being driven at speeds comparable to the early airplane and airship, have been sadly neglected, until lately.

Yet, while the **rolling** resistance (that of the road) is nearly constant—increasing only slightly at higher speeds—if the speed is doubled, the **air** resistance increases four times, and eight times as much power is used! At 40 miles per hour, in the case of present standard-make machines, about **half** the power is used just to overcome the air resistance.

Airplane engineers have found this air resistance to be of two kinds: **skin friction,** and **form resistance.** The skin friction is always present in moving bodies and it constitutes only from 10 to 15% of the total air resistance of the automobile of today.

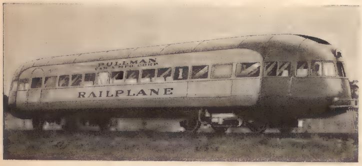
The remaining 85 to 90%, known as form resistance, is due to the turbulent eddies and whirls caused as the car passes through the air. Automobile designers are experimenting in an endeavor to reduce it and, theoretically, it may be entirely eliminated.

Perhaps you have noticed, as an automobile passes rapidly down a leaf-strewn road, that the leaves fly around in the air long after the car has passed. This area of disturbed air extends upward and outward, far beyond the space through which the car actually passed.

It was found at the University of Michigan that merely curving square corners to a 6-inch radius gave a noticeable decrease in drag, especially at high speeds. In the University of Detroit's wind tunnel, an increase of about 20 miles per hour was secured by inclining the windshield and removing the visor or sun-shield of a car.

In tests conducted recently at the University of Michigan, under the supervision of Prof. Walter E. Lay, bulging sides, for instance, showed a reduction of about 18.8% in air resistance, as compared with a machine with straight or flat sides. Likewise, the V-type radiator, slanting 45 degrees, showed [illegible] decrease of approximately 11.2% in resistance or drag, as compared with the flat, vertical radiator of a few years ago. The curved radiator, however, showed an even greater reduction, about 21%.

Tests show that it is useless to attempt much streamlining of the rear, unless the front of the machine is inclined or slanted. A model with [illegible] perfectly streamlined "tail" but a vertical radiator and windshield showed almost no decrease in drag when compared with a model of the same size and the same front but with the conventionally designed rear (i.e. more or less vertical). Application of this may be seen in that the majority of the 1933-design automobiles show definite attempts at streamlining the front, although the rear remains somewhat blunt and square. And it is the absence of streamlining of the rear that still keeps the air resistance very high.—Rollin Fairbanks.



Above, the new streamlined coach of the Pull[illegible] Car [illegible] Mfg. Corp., designed [illegible] aviation principles for 90 miles an hour, and named the Railplane. The frame is chrome-molybdenum steel, the welded, one-piece shell duralumin: the weight is 25,000 pounds [illegible] against 160,000 for the standard Pullman coach. It is powered by two automobile-type motors, one driving each axle of the front truck. The power required is much lower than in [illegible] standard car; 50% of the wind resistance being overcome.

Left, Marcel Berthet, French cycling champion, with his streamlined bicycle housing, permitting 32 miles [illegible] hour. (Front view, page 872.)

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Breaking Up Tornadoes

(Continued from page 905)

ment that speeds of 300 miles per hour or 440 feet per second, and even more, may be attained, which is most unlikely to be the case. It must be borne in mind that an air blast of 150 feet per second readily carries off bricks and other such heavy objects.

(2) Contrary to popular notion, attributing to the tornado immense energy, it has much of the peculiarity of an explosive. Its power is great because of concentration and swiftness of action, but the energy is surprisingly small. Just to give a rough approximation, consider a whirl of an outside diameter of 1200 feet at the top, about the same height, and a diameter of 300 feet at the base **(See Note C)**. The same energy would be developed by the consumption of 1.24 tons of gasolene or 5.74 tons of dynamite. It should be stated, however, that this estimate is by far too high; for the whole funnel is not filled with air of uniform density and not all of it spun at maximum speed.

(3) The tornado whirl is a huge pump, drawing air through the opening at the top and discharging it from the periphery (rim) at the same rate, simultaneously producing rarefaction in the interior. In this respect its action may be likened to that of a multi-staged vacuum pump; for, as the air rushes from the top to the base, more and more of it is drawn to the periphery, increasing progressively the vacuum which may thus attain a high value near the ground. That accounts for the gradual contraction of the whirl. What degree of rarefaction is actually reached in this monstrous contrivance of nature may be roughly estimated when considering that, for any horizontal section of the funnel, the centrifugal force of the air is balanced by the oppositely-directed differential pressure existing between the outside and interior of the whirl. Other things being alike, the centrifugal force is inversely [redacted] the **radius of gyration** (average distance of the mass from the center); therefore the contraction of the funnel is, at least, a coarse measure of the rarefaction.

To be explicit, if the diameter close to the ground is one quarter of that near the top, then it may be safely inferred that the vacuum at the base must be about four times higher than in the top region, where there is no appreciable contraction.

As the measured pressure difference in pumps is somewhat greater than that given by the formula **(Note D)** it is tolerably certain that in the case considered a vacuum of not less than four inches would be attained.

(4) Most of the mechanical effects of a tornado are, as a rule, greatly intensified through water, dust, sand and other objects carried by the blast. Even though these materials may be present in a very small percentage by volume, they are hundreds or thousands of times heavier than the air, and may add enormously to the momentum and impact.

(5) The translatory (from place to place) motion of the funnel is rather across, and not in the direction of the wind, as commonly believed. This is due to its rapid rotation, causing the so-called Bernouilli or Magnus effect, only much more intense. The force pushing it across the wind may be many times greater than that urging it along the same. The whirl is propelled from the side of greater static pressure, where the rotation is **against the wind and to-**

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wards which it leans, in the direction of the opposite side where the reverse condition exists. It is well to remember this in such a storm. If the observer sees a leaning funnel, he is in no immediate danger, but if the funnel appears straight he should run for shelter at once.

It will now be easy to show how a large and very heavy body, such as a loaded railroad car or locomotive, can be lifted by the tornado and transported to considerable distance. American locomotives, which are the biggest in the world, may have a length of 66 and a width of 11½ feet, presenting thus 760 square feet in horizontal projection. At the moment the whirl strikes the vehicle, the wheels, connections and other obstacles under the main body arrest the motion of the air, causing a static pressure of 138 pounds per square foot in excess of that of the atmosphere. But as determined above, owing to the vacuum, a pressure difference of four inches of mercury (that is, two pounds per square inch or 288 pounds per square foot) is maintained, making the whole difference of pressure between the spaces under and above the locomotive $288+138=426$ pounds per square foot. The total upward push exerted on the exposed area of 760 square feet is thus 323,760 pounds, which is much more than the weight of such a locomotive (estimated at 280,000 pounds when fully equipped for service).

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The constant fear of danger from tornadoes and the great losses of life and property which they cause in certain parts make it very desirable to find some means of effectively combating, if not preventing them. Whenever man attempts to interfere with the order of things determined by immutable laws, he finds that his efforts are utterly insignificant when compared with the vast movements of energy in Nature.

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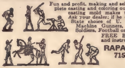

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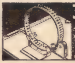

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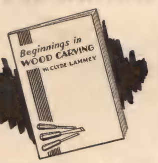

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manifestations are of comparatively small energy. It is entirely within our power to destroy them, or at least render them harmless; and all the more easily, since meterorology is becoming a positive science and weather forecasting reliable.

A service with standard bombing planes or swifter types might be organized for this purpose by the Government, for the necessity is real. The tornado, owing to its small energy, extreme mobility and delicate balance between the external and internal pressure, is a very vulnerable object and can be undoubtedly destroyed by comparatively small charges of suitable explosive. The whirling mass can also be easily deflected in any desired direction by exploding a charge even at a considerable distance from it. The task would be further facilitated by the relatively small translatory velocity of the tornado, especially in view of the present means for instant signalling.

I believe, however, that telautomatic devices offer effective means for combating tornadoes. Since I exhibited the first apparatus of this kind, John Hays Hammond, Jr., who has acquired a great mastery of the art, made demonstrations on a large scale, showing the practicability of distant control of complex machinery. It would not be difficult to provide special automata for this purpose, carrying explosive charges, liquid air or other gas, which could be put into action, automatically or otherwise, and which would create a sudden pressure or suction, breaking up the whirl. The missiles themselves might be made of material capable of spontaneous ignition. Many experts are now available for such service and manufacturers can be found competent to carry out any plans.

A Government department might be organized, headed by such a man as John Hays Hammond, Jr., and a systematic study of the problem made. The carrying out of the scheme would give new opportunities for manufacture and employment, besides securing other advantages. There is no doubt that, if such an undertaking were inaugurated and many minds set to work, effective methods and means would be eventually developed and great loss of life and damage to property prevented.

NOTE A: Taking the heating value of the compound as 4100 B.T.U., a constant pressure of twelve thousand atmospheres should be attained; the theoretical temperature of the combustion products being about 8000° F. The highest possible speed would be reached if the gases were to escape into the atmosphere through a perfect divergent nozzle. In this case, the initial absolute temperature would be $T_1 = 8460°$ F.; hence the absolute temperature of the fully-expanded gases $T_2 = \frac{0.285}{8460/12000} = 583°$ F. Accordingly, assuming the specific heat at constant volume $C_v = 0.33$, the available energy is $W = 7877 \times 0.33 = 2600$ B.T.U., and the maximum theoretical velocity $V = \sqrt{64.4 \times 778 \times 2600} = 11400$ feet per second.

NOTE B: Let the stalk be one foot long, one-eighth of an inch in diameter and of a specific gravity of 0.4 as compared with that of water. The section is then about $\frac{1}{80}$ of a square inch or $\frac{1}{144 \times 80} = \frac{1}{11520}$ of a square foot and, consequently, the volume $\frac{1}{11520}$ of one cubic foot. Since one cubic foot of water weighs 62.45 pounds, the weight of an equal volume of straw will be $0.4 \times 62.45 = 25$ pounds, hence the weight of the piece of straw $\frac{25}{11520}$ pounds and its mass $M = \frac{25}{32 \times 11520}$. Then the kinetic energy is

$$\frac{1}{2} M V^2 = \frac{25 \times 22500}{64 \times 11520} \text{ foot pounds}$$

and will be exhausted in overcoming a resisting force r which the stalk encounters while piercing the wood. If the distance of penetration is 1/2 inch or 1/24 of a foot, then the equation will hold true

$$\frac{22500 \times 25}{64 \times 11520} = r \times \frac{1}{24}$$

from which follows

$$r = \frac{24 \times 22500 \times 25}{64 \times 11520} = 18.31 \text{ pounds}$$

This is the mean value of the force or pressure produced, its maximum being

$$2 \times 18.31 = 36.62 \text{ pounds}$$

As this pressure is exerted on an area of $\frac{1}{80}$ of a square inch, the force per square inch will be

$$F = 36.62 \times 80 = 2929.5 \text{ pounds}$$

NOTE C: The volume is $0.2618\ H\ (D2 + d^2 + d\ D) = 0.2618 \times 1200\ (1200^2 + 300^2 + 1200 \times 300) = 0.2618 \times 1200\ (1200^2 + 1200 \times 300) = 593760000$ cubic feet, the weight about $593760000 \times \frac{8}{100} = 47500000$ and the mass $M = \frac{47500000}{32} = 1484400$ pounds. If all of it would rotate at the top speed $V = 235$ feet per second, the kinetic energy would be $\frac{1}{2} M V^2 = 742200 \times 55225 = 40988000000$ foot pounds, equivalent to $\frac{40988000000}{778} = 52700000$ B.T.U.

NOTE D: When a mass of air is rotated in a casing with inlet and outlet openings, by a system of discs or other means, the peripheral velocity being V feet per second, a pressure difference of approximately $^{V^2}w = \frac{V^2 \times 0.08}{64} = \frac{V^2}{800}$ pounds per square foot is produced between the suction and discharge orifices. If $V = 235$ feet per second, then $\frac{V^2}{800} = \frac{55225}{800} = 69$ pounds per square foot, or $\frac{69}{144} = 0.48$ pounds per square inch; corresponding to a vacuum of a little less than one inch.

New Devices

(Continued from page 877)

The last item is another household utility which takes into consideration the fact that all have not electric power. It is a standard washer type, equipped by its maker with a small four-cylinder gas engine, which is started by a foot-pedal. A friction-drive pump will empty the tub in less than two minutes. It holds ten gallons of water, and washes six pounds of clothes at one time.

Producing Chlorine

(Continued from page 889)

of the anode compartment. The hydrogen exit is in the top of one cathode compartment, both cathode frames being connected by tubes on top to equalize the pressure. The caustic liquors are brought out from the lower corners of the cathode compartments to a "T" piece, and thence to an overflow tube. The anode liquor is brought from the center of the bottom of the anode compartment, through an end piece to another overflow tube. The brine solution fed to the cell goes down a thistle tube to a "T" piece, and thence to the bottom centers of the two electrolysis compartments. The various holes in the frames for gas and liquor exits and inlets should be made a trifle larger than the glass tubing to be used; the tubes are then cemented in place by using a little waterproof cement.

The cell as built yields about 450 grams of sodium hydroxide (as a 12% solution) and from 300 to 350 grams of chlorine for each kilowatt-hour used. The strength of the alkali producer depends on the rate of liquor flow; which, in turn, depends on both the feed-liquor head and the porosity of the diaphragms. For best results with this cell, when making a 12% sodium hydroxide solution with a current of 5 amperes to each cathode (10 amperes to the entire cell), adjust the feed-liquor head so that cathode and anode liquors each escape at the rate of about 3 cc. per minute. Once the proper feed-liquor head has been found, the feed can be made automatic; by the well-known method of using as a reservoir for the brine an inverted flask, higher than the thistle tube, bearing a one-hole stopper and a glass delivery tube which just touches the level of the liquid in the thistle tube.

The liquor fed to the cell is made by saturating distilled water with ordinary coarse salt, using about 300 grams per liter of solution. If desired, the brine may be purified by adding about 10 grams per liter of sodium carbonate, and decanting or filtering from the precipitated calcium and magnesium carbonates.

To recover the sodium hydroxide, boil down the cathode liquor (best to use a clean iron dish) until the dissolved unchanged salt is separated. Allow this to stand until settled; decant the strong alkali solution; and then heat this in an iron dish to remove the balance of the water; getting, finally, fused sodium hydroxide at about 300-320° C. This fused alkali, when cool, may be broken up and will be fairly pure; containing not more than a few per cent of salt.

The anode liquors are boiled a short time to remove the dissolved chlorine; and the liquid may then be resaturated with fresh salt or with the salt obtained from purifying the caustic liquor, and used as additional feed to the cell.

New Tools You Can Make

(Continued from page 896)

other end is countersunk at a similar angle for a small ball. The upper clamp strap is drilled and countersunk to correspond with the holes in the base. It will also be noted at A that two additional clamp-screw holes, a, a^1, are drilled in the strap. These are provided so that the "small ball" hole can be aligned with the corresponding hole of the base (when it is inverted).

This tool is centered and used in the following manner: remove the clamp strap and its screws, and loosely bolt the base to the lathe faceplate. Advance the tailstock spindle until its center engages the base center hole, and presses the tool base against the faceplate. Now tighten the base securely to the plate, and withdraw the tailstock. The device is now centrally mounted; and any ball which is clamped in it can be very accurately drilled if the proposed hole is first started with a combination center drill. A similar procedure is used to clamp this tool on the drill-press table.

An Improved Threading Tool

■ BEGINNERS who have experienced difficulty with screw cutting on the lathe will find a great help in the improved tool drawn and diagramed in Fig. 4. With this circular tool, smoother and cleaner threads result on the work because of the multiple cutting edges (B, Fig. 4). The cutting threads of the cutter head B are first rough-chased in the lathe; then they are finished with a standard die of the pitch required. After applying the rear stud threads, the unit is hardened and tempered.

As indicated in the top and the side views of Fig. 4, the cutter head is ground to form after hardening. For the front cutting edge, select a spot on the rim of the cutter head where three full threads are evident (as shown by the arrow at B), and grind at this point.

In using, it is not even necessary to use a gauge to set the tool. Apply the tool to the work under a very light screw-cutting feed, and observe the markings which the three edges describe along the work (arrow of A, Fig. 4). If the three lines are uniform in width and depth, the tool is correctly set in relation to the work.

Smoker's Stand and Rack

(Continued from page 893)

pipes on the wooden tray on top, and has room enough for ashes in the center. The racks will conveniently hold magazines or books, and the spaces formed by the two divisions on either side of the column can be used for a small tobacco humidor or cigarette box.

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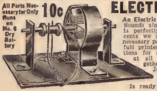

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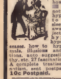

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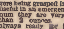


A wonderful little instrument producing optical illusions both surprising and startling. With it you can see what is apparently [illegible] bones of your fingers; t[illegible] lead in a l[illegible] pencil, the interior opening in a pipe stem, and many other similar illusions. **Price 10c, 3 for 25c.**

Exploding Matches

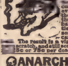
10c

[illegible]e fun than fighting [illegible] your wife. They look just [illegible] ordinary matches but explode with a loud bang when lit. 12 matches to a box. **PRICE 10c per box, 3 boxes 25c, or 75c per doz. boxes.** Not mailable. Shipped by Express only.

[illegible]TCHING Powder

[illegible] [illegible] discomfiture of your victims to everyone but themselves is thoroughly enjoyable. All that is necessary to start the ball rolling is to deposit a little of th[illegible] powder on a person's ha[illegible] [illegible]nd the powder can be re[illegible] upon to do the [illegible]. The result is a vigorous scratch, then some [illegible] scratch, and still some more. 10c box, 3 boxes [illegible]5c or 75c per dozen. Shipped by Express.

ANARCHIST BOMBS



One of these glass vials dropped in a room full of people will cause more consternation than a limburger cheese. The smell entirely disappears in a short time. **10c. per Box, 3 Boxes for 25c., 75c per doz. Boxes, or $7.50 per gross Boxes.** Shipped by Express. Not Prepaid.

SNEEZING POWDER

Place a very small amount of this powder [illegible] the back of your hand and blow [illegible] into the air, [illegible] watch them [illegible] without knowing the reason why. It is most amazing to hear their remarks, as they never suspect the real source, but think they have caught it one from another. Between the laughing and sneezing you yourself will be having the time of your life. *For parties, political meetings, car rides,* or any place at all where there is a gathering of people, it is the *greatest joke out.* **PRICE 10c, 3 for 25c, 75c per dozen.** Shipped by **Express.** Not Prepaid. *770 page Novelty Catalog 10c.*

COMICAL MOTTO RINGS

KISS ME AGAIN I'M STILL CONSCIOUS

Lots of [illegible] fun [illegible] amusement wearing these rings. Made in platinoid finish (to resemble platinum), with wording on enameloid, as illustrated. **Price 25c. ea. Postpaid.**

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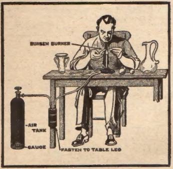
WRINKLES

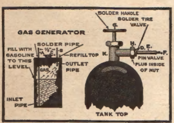
A Gas Plant for Your Laboratory



A simple method of obtaining gas from gasoline is described in the accompanying text. Gauze in the burner base is advisable, to prevent a "kick-back."

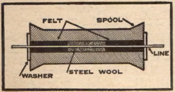
● THE experimenter who is fortunate enough to have a small laboratory, in a garage or shed, generally finds that he has to resort to an alcohol lamp for his heat supply. Here is a method for making a gasoline gas generating plant at a cost not exceeding a dollar and a half. First, an acetylene tank is procured from an auto junk yard; these tanks were formerly on trucks to supply gas for the lights. The tank should be in good condition and have a pressure gauge at the bottom. Connecting nut H should be on the tank when you buy it. Remove this nut; take out the plugs which it contains, and redrill to take a tire valve, E. Solder valve handle G on valve head.

The generator unit consists of any suitable tank with a filler top into which two pipes, one short and one long, are fitted. This is strapped to the table leg after being half filled with gasoline. Pump up the air tank with air, tighten valve G, remove needle valve (F) in auto tire valve, attach rubber tubing to gas generator and Bunsen burner, then open the air valve to allow the air to pass through the gasoline. You will get a plentiful supply of good fuel.—Michael Spacek.



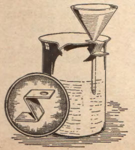
A and B are tubes soldered into can fitted with filler top C. An acetylene tank is filled with air to supply the pressure.

Spool Cleans Metal Clothesline



Cross section through the steel wash line cleaner.

● THREAD a medium-sized cotton spool on a line, stuff fine steel wool into the center of the spool, and pack felt on each side so that the hole is completely filled. Cement a faucet washer on each side of the spool so that the contents stay in. To clean a line, slide the spool from one end to the other.—Thomas A. Blanchard.



Filter Funnel Holder

● A CHEAP practical device to hold the funnel in a beaker is a piece of sheet aluminum, drilled and bent as shown. If the funnel is removed, the greater weight of the part of the holder outside the beaker makes it impossible for the holder to fall in.—"English Mechanics."

THESE convenient Post-slips are for assistance to our readers in answering the advertisements whose addresses appear below. It overcomes mutilating the magazine pages. Simply copy name and address of advertiser on a regular one-cent government postcard and paste coupon on other side. Or you can address and insert in an envelope which requires three cents postage.

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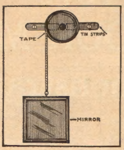
Ingenious Mounting for Mirror

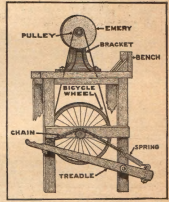
● MANY methods have been developed for making mirrors adjustable. Most of these rely on tilting the mirror for "height" adjustments, but the actual position of the mirror with relation to its height is virtually unchanged. Here is a way by which the height of the mirror can be varied at will, and the mounting itself is cheap. As will be seen, a 10c spring tape measure has a brass strip soldered to it for mounting to the wall; the mirror is hung from this tape. This system can also be used for lights; if they are heavy, wind one turn of tape around the drum.—A. S. Wurz, Jr.



Press button, to unlock tape measure, to adjust height of mirror.

Foot-Driven Emery Wheel

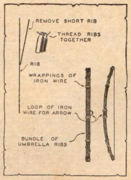
● A VERY serviceable foot-powered emery wheel can be installed on the edge of a work bench as illustrated at the right. As will be seen, practically all of the drive is obtained from parts of a bicycle rear wheel. The ratchet part of the coaster brake is used for the axle, and the whole mounted on a cross-brace of a bench. A piece of chain with a spring inserted is attached to the foot treadle. Downward push on the treadle spins the wheel, and the spring brings the treadle back.—A. S. Wurz, Jr.



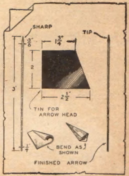
The coaster brake allows the wheel to continue its spinning.

Bow from Umbrella Ribs, and Arrows

● HERE is a simple method of constructing a rather powerful bow from umbrella ribs. Seven umbrella ribs are required. The short brace is removed from each rib, and all the ribs threaded together through the holes at both ends. A bundle is made of the ribs, all of the hollow portions facing the inside, and they are tied together by wrappings of wire at the ends. The bow string should be very strong; piano wire being preferred, but leather or gut string may be substituted if desired. Arrows are made of rounded, straight-grained pieces of wood, pointed with metal tips cut from a piece of tin. The bow is powerful enough to shoot to a distance of about 200 yards, and at 50 to 75 feet its accuracy is astounding.—Carl Deck.



The construction of a bow from a bundle of steel umbrella ribs is here illustrated.



This gives the details for making metal arrow points. Arrows are not unfeathered.

Let Me Prove What YOUR Mind Can Demonstrate

Famous Rosicrucian Mystic Explains Secret Method Used by Many Thousands

ARE you weary of reading the books that tell you about the wonderful things accomplished by the master minds of the past? Are you tired of hearing what **can** be done with the mystic laws of mind and matter, without being told how YOU can do these things, easily and surely?

If you are like thousands upon thousands of others, you will want to be MASTER of your own life, your own career. You will cease believing the fantastic tales of the adepts of the Far East and the Mystics of the Orient, and will demand that you be shown **how to do these great demonstrations of occult power.**

For ages, man has accepted the doctrines of church and school on faith. Today man demands the **knowledge** of the methods for self demonstration. His life and his fate are in his own making. He no longer believes that God has damned some to hell and some to heaven before birth. **He wants to rise, master, succeed and create for himself.** He has discovered that it is his Divine Heritage. Telling him that it is possible for man's mind to accomplish miracles without explaining how and revealing the secret laws, has brought discouragement, sorrow, failure, and doubt into the hearts of millions.

But the great truth of the matter will never be found in books. This fact is not frankly told to the seeker, and he is led to buy books, and buy, and buy. Lecturers, teachers, writers and self-appointed guides continue to talk about what CAN BE DONE, and leave a host of hopeful but blind searchers for the knowledge they seek.

Certainly there must be some truth in the claims made and the stories told. For hundreds of years, in all countries, there have been noted men and women who demonstrated a rare and dependable system of **creative mind power,** and whose rise to success and attainment was miraculous. It is because we contact today those who seem to possess some unusual knowledge and a secret key to nature's bounties, that thousands still have hope and believe in the pot at the end of the rainbow.

H. SPENCER LEWIS, Ph. D., F. R. C.
Imperator of the Rosicrucian Brotherhood

The real knowledge, however, is not publicly distributed to the worthy and unworthy alike; nor is it offered on a commercial basis like some earthly commodity of man's manufacture. The knowledge is from a sacred source; it is a priceless gift to the pure in heart and the deserving. Its value has been preserved by its careful protection from the sordid and completely selfish minds. This rare and secret wisdom of the higher laws of mind and nature has remained in the charge of one very ancient Brotherhood, the Rosicrucians, who proved years ago their great love for mankind, their broad tolerance and their willingness to help all to attainment and success if worthy.

Today the fraternity of Rosicrucians, existing in all lands and known as the AMORC, offers the real and true knowledge of man's potent powers over matter and mystery. Those who are ready to study, practice and master, step by step, may have the complete knowledge under a very liberal arrangement that is not inconsistent with the high ideals of the Great School of the Great White Brotherhood. It will mean the complete change of fortune for any man or woman who follows the instructions and lives the happy, creative life of a Rosicrucian. Thousands, in all parts of the world today, in the highest positions of power and demonstrated success, are secret students of the Rosicrucian methods.

I personally invite every **real seeker** of worthy mind and sincere heart to write to my librarian for a complimentary copy of a book that will explain the history and methods of instruction of the Rosicrucian Order known as AMORC in all lands. **Use the Coupon** below for your copy of the FREE BOOK.

The Wisdom of the Sages

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Friar N. V. D.
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